QUESTED'S
ART OF
LAND
SURVEYING

43. 759.

ART OF LAND SURVEYING.

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ART OF LAND SURVEYING,

EXPLAINED BY SHORT AND EASY RULES;

PARTICULARLY ADAPTED

FOR THE USE OF SCHOOLS,

AND SO ARRANGED AS TO BE

ALSO USEFUL TO FARMERS, STEWARDS, AND OTHERS.

BY

JOHN QUESTED,

SURVEYOR, MAIDSTONE.

TO

MR. JAMES TEMPLE,

PRINCIPAL OF CLIFF HOUSE SCHOOL,

St. MARGARET'S, near DOVER.

I know not to whom I could more appropriately dedicate the following pages, than to yourself, my early friend—the friend, too, of my riper years; and the conductor of that school at which I received my education.

Many times, during the hours of my writing this little work, have reminiscences of bye-gone days crossed me as a cheerful dream; and have enlivened the hours when I laid down my pen.

Added to this, it is to you that I am indebted for the plan of the work; had you not proposed the task, I had never attempted it. How far I have carried out your wishes remains for you and the public to judge;—to you and the public I bow with humble confidence, in the earnest hope that my efforts may not entirely have failed.

REFERENCE.

INTRODUCTION.

THERE are several treatises extant on land surveying all more or less calculated to instruct the pupil, so as to render him a complete *professional Surveyor*. With these works I am not entering into competition; my sole object is to produce a few pages, which, being placed into the hands of school boys, who are to follow the business of farmers, may give them such a knowledge of surveying, as may enable them to do all that is needful in that art, on the farm.

I have repeatedly noticed that when boys at school have been required to learn land measuring, for facilities in farming, large works, containing some hundreds of pages have been placed in their hands, the chief portion of which is devoted to geometry and the construction and calculation of abstruse figures, never likely to be required by that class of pupils for whom I am now writing. Far be it from me to limit the acquirement of knowledge, or to say that such acquaintance with geometry is useless; I merely contend that a more simple method, one divested of those intricate and necessary problems to the pupils destined to follow surveying as a profession, may save much time and expense, and yet give a sufficient knowledge of the art

to the farmer or steward. For this purpose I confine my geometrical figures to a very few pages, reserving explanations of such others as may occur in the course of the work, to the examples as they follow. My object will be to conduct the pupil by the simplest methods to the attainment required. My language shall be plain and easily to be understood; and if at times it may appear that I dwell too long on *minor* points, at least what may be thus deemed by the professional man, and him who is already practically acquainted with the study, I would beg again to remind him that it is for the *farmer* I write, and that to him these minor points are the most useful.

I have, in the course of my practice, seen lads who have studied surveying at schools, have drawn neat plans, performed abundance of examples, inserted them in their books; and, in short, have become, as far as their opportunities of learning allowed them, a credit to their teacher; but, mark me,—these lads, when on reaching home, and on being required by their father to measure a piece of ground for mowing, or otherwise, and thus put to a little practical work, betray a total want of knowledge of that which was required of them; and although well acquainted with the construction of geometrical figures, the calculation of abstruse questions, and their head crammed with a catalogue of "hard words," they have no idea of *measuring in the field,* and are obliged to confess that there is a wide difference between the study of geometry, and plain, simple land measuring. I would therefore

impress upon every master to let the pupil frequently "take the field," first to draw the chain, next to guide it, and afterwards to keep the book

A knowledge of the following tables is very necessary.

LINEAL MEASURE.

INCHES.	LINKS.	FEET.	YARDS.	RODS.	CHAINS.	MILE.
7·92	1					
198	25	16½	5½	1		
396	50	33	11	2		
594	75	49½	16½	3		
792	100	66	22	4	1	
63360	8000	5280	1760	320	80	1

LAND OR SQUARE MEASURE.

INCHES.	LINKS.	FEET.	YARDS.	PERCHES.	ROODS.	ACRE.
144		1				
1296	20.66	9	1			
39204	625	272¼	30¼	1		
1568160	25000	10890	1210	40	1	
6272640	100000	43560	4840	160	4	1

THE ART OF LAND SURVEYING.

EXPLANATION OF A FEW GEOMETRICAL FIGURES.

1. A point has neither length, breadth, nor thickness.
2. A line is length without breadth, as line A B.

A————————————B

3. Parallel lines are lines drawn equally distant from each other, consequently extended to any length, would never meet, as line A B is parallel to C D.

A————————————B
C————————————D

4. An angle is the meeting of two lines running from an opposite direction into one point, not forming one straight line.
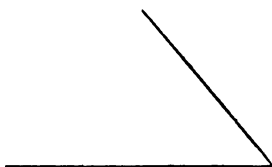
5. Angles are either right, acute, or obtuse.
6. A right angle is formed by one straight line standing on another, in an upright or perpendicular direction, thus the line C D is at right angles, or
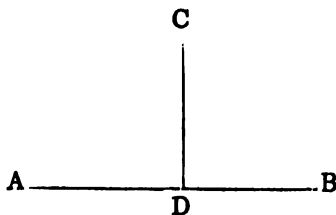
perpendicular with A B ; that is to say, the point C is equi distant from A and B. This figure repeatedly occurs in plotting, and to construct it, see problem 1st, page 7.

7. An acute angle is *less* than a right angle, as A C B.
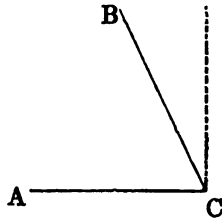
8. An obtuse angle is *greater* than a right angle, as A C B.
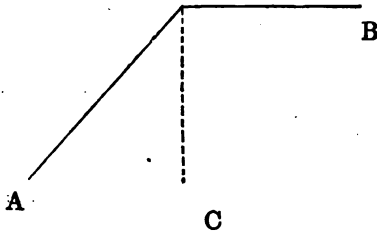
9. A circle is formed by a curved line, drawn equally distant from a point within, called its centre.

Every circle, great or small, is supposed to contain

360 degrees; hence the semi-circle 180, and the quarter or quadrant 90.

The diameter of a circle is defined by a direct line running from the circumference, through the centre, to the opposite point of the circle, as A B.
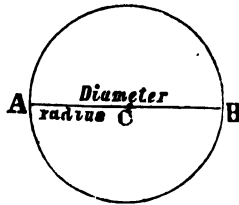
The radius is one-half the diameter, as A C.

The word radius frequently occurs in the explanation to the following figures; it is, in fact, the distance between the two legs of the compasses, taken for the purpose of striking a circle, or arcs of a circle, for the intersection of lines.

8. Triangles are figures of three sides, being the smallest number of right lines that can include a space.

9. A right-angled triangle has one of its angles right, or containing 90 degrees, (the fourth part of a circle.)

Base.
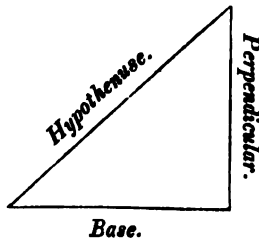
10. An acute-angled triangle has all its angles acute, none of them being equal to 90 degrees.
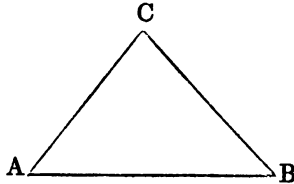
11. An obtuse-angled triangle is that which has one obtuse angle ; that is, an angle containing *more* than 90 degrees, as A C B. The angle D C B is a right angle.
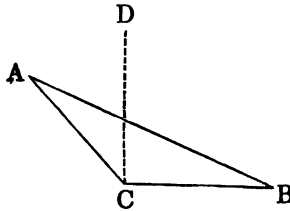
PROBLEMS

For the construction of the foregoing Figures.

PROBLEM 1.

To raise a perpendicular, from a given point, on a given line, that point being at, or near, the middle of the line.

Let C be the point from which the perpendicular is to be raised, on the line A B.
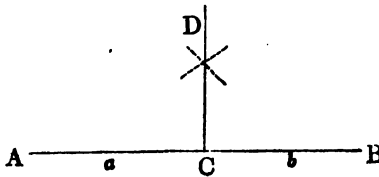
From the point C, set off two equal distances, on line
A B, as C *a* C *b*; and with any radius greater than
C *a*, and with one foot of the compasses in *a*, as a
centre, describe an arc; then with the same radius, and
b as a centre, intersect that arc in D; draw the line
D C, and you have the perpendicular required; in
other words, D C is at right angles with A B, or that
line with D C, see figure 9, page 6. This problem
is very simple and very useful; scarce a field being
measured or computed without its aid.

It occasionally happens that the perpendicular is
required at or near the end of the line; when this
is the case, unless you can conveniently extend the line,
proceed as follows. Let it be required to erect a per-
pendicular on point B.
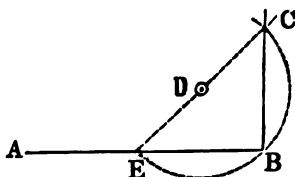
Take any point (out of the line) as D for a centre,
and with the radius D B describe an arc, cutting A B
in E, draw a line from E, through D, and its place of
intersection with the arc, at C, will be the point for the
perpendicular required.

The first figure to which the above problem may be
applied is in the construction of a square, which is thus
done.

PROBLEM 2.

To describe a square whose side is equal to A B.
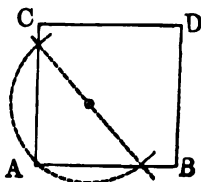
Raise a perpendicular from A, which may be done either by extending the line A B, at either point, so as to make use of the 1st rule, in problem 1; or it may be done by the 2nd rule. Make this perpendicular A C equal to A B, then with the radius A B, and the last found point C for a centre, describe an arc, at D, and with the same radius, and B for a centre, cut the arc D, draw lines from C to D, and from D to B, and the square is formed.

PROBLEM 3.

To describe a rectangle, or a parallelogram, whose angles are all right angles, and whose sides A B and B C are of a specified length.

Let A B be 500 links, and B C 300 links.* Set off the length of line A B.
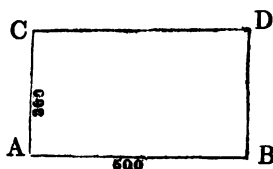
Erect a perpendicular at either A or B, by one of the preceding rules, and mark off its length C 300. Then with the same length, and from B as a centre, describe an arc at D, and with the radius A B, and at C for a centre, cut the arc at D, draw the lines to the respective points, and the parallelogram is complete.

The method of drawing other four-sided figures will be found fully explained in the body of the work, as such figures occur in practice; see the observations on the Trapezium, &c. &c. Presuming that the pupil fully understands thus far, and in order to this, he should amuse himself by describing different figures, either on his slate or waste paper, taking care to observe neatness and accuracy in his work, otherwise the more he studies and practices, the more he will imbibe systems of error;

* Or feet, yards, or any other lineal measure; these are taken on a scale of equal parts.—See page 10.

in the supposition, then, that he has made himself master of the foregoing, we will proceed to explain the method of measuring land on what I consider the simplest and most correct principle.

TO SURVEY WITH THE CHAIN.

It was formerly the custom for surveyors to take into the field, if merely required to measure a piece of land of trifling extent, almost as many instruments as would fit out a pioneer in apportioning the land of a new colony. Besides his chain, he incumbered himself with a large, heavy cross staff, shod with iron, several staves of about five feet high, also shod, a very heavy link staff, and the iron pins, or arrows, so stout, as to be almost fit for bolts.

Unless for very extensive surveys, or exceedingly intricate work, I seldom take with me more than my chain, pins, and link-staff; which latter is made as light as possible; always taking the precaution to provide myself with a good strong pocket knife for the purpose of cutting sticks for stations.

THE CHAIN.

Gunter's chain, so called from the inventor, Mr. Gunter,* contains 100 links, and on this chain are based the tables of lineal and square measure, page 3. For the convenience of counting, a brass mark is placed at every ten links, in the following way.

THE PINS,

Ten in number, should be made about 18 inches in

* A celebrated Mathematician, born in Herefordshire, in 1581.

length, of iron wire, slight, but sufficiently stout to prevent their being bent by every trifling obstacle in thrusting them into the ground.

The Link Staff

is usually a light piece of fir, or an ashen, or willow wand, ten links long, (sometimes 15,) and marked at each link, making the fifth a little more conspicuous to assist in counting. If pointed at one end, and grooved at the other, the better.

The Plotting Scale

is commonly made of ivory, or box wood, and should be feathered edged, being more convenient for plotting. It is made of various sizes, and dimensions, some being divided into 1, 2, 3, or 4 chains to the inch; and these divisions into ten equal parts, of ten links each, corres- ponding to the divisions of tens on the chain, and these are supposed to be sub-divided into other ten equal parts, or links. I would recommend the use of scales of 2 or 3 chains to the inch.

Example 1.

To begin with a simple figure, let us imagine a square field, as A B C D.
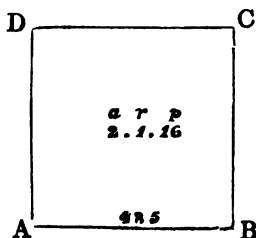
If perfectly assured that it is a square, you have but to measure one side, as A B, which suppose is 485 links in length, that is 4 chains, 85 links; and to find the area,

multiply the side by itself, and the product will be the area.

$$485$$
$$485$$

$$2425$$
$$3880$$
$$1940$$

Acres 2.35225*
$$4$$

Roods 1.40900
$$40$$

Perches 16.36000

* area in square links; now as 100,000 square links make an acre, divide by that number, or cut off 5 figures on the right hand, those on the left are acres,† multiply

† I have been frequently asked by my pupils, why the five places of decimals are cut off, the reason is obvious; let us divide the product before us, by the number of links in an acre, thus—

links in an acre
100000)235225(2 acres
$$200000$$

$$35225$$
$$4$$

100000)140900(1 rood
$$100000$$

$$40900$$
$$40$$

100000)1636000(16 perches
$$100000$$

$$636000$$
$$600000$$

$$36000$$

The result of the work is the same, but the number of figures between the two operations is widely different.

the five figures by 4, because 4 roods make an acre, cut off five again, those on the left are roods; multiply the remainder by 40, because 40 perches make 1 rood, and cutting off the five decimals, the figures on the left are perches.

The above field is measured and calculated on the *certainty* of its being a square, but should a doubt arise, it would be better to measure each side separately, and so ascertain the fact.

And here it may be well to give the pupil a few instructions as to the method of measuring. On entering the field, draw a *rough sketch*, as it is called, but the more neatly this is done, the better; then standing at the point A, with one end of the chain in your hand, let your assistant take the other end, and the ten pins, (one of which he should have in the hand with the chain) and proceed towards B. At the extremity of the chain, which must be kept quite tight, he must put down the pin, you taking care to keep him in a direct line with station B. To do this, little or no talking is required,—a wave of your hand to the right or left, will be a sufficient guide; custom will soon convince you of this, for by much talking, mistakes occur; I have been out whole days, and have scarcely spoken while the chain is going. Let the assistant then proceed, and at each chain put down a pin; these you collect as you go on: when arrived at the point B, count the number of pins you have, which, in the example before us, will be 4, (or 4 chains,) and on going to B, you find the odd links will be 85,* mark this in your sketch as above. Give up your pins to the chain man, (assistant,) whose duty it is always on your doing so, to see that he has the right number, (10,) and in like manner, measure from B to C; note this down also, which, if it be an exact square, as per example, will be 485; again give up your pins, and proceed from C to D, note down the extent, give up your pins, and then measure to A.

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* I entreat the pupil's patience, while I just mention, that it is better in almost all cases, on reaching a station, to let the chain-man draw the chain beyond the station, and so continue to count forwards, rather than for the man to stop at the station, and the surveyor count backwards, as I have known many very serious errors occur by the latter method.

I have been thus prolix in describing the method of using the chain, as one example properly given will suffice. But when the line exceeds ten chains, it is well to direct the man to make with his foot, a mark in the ground, at the tenth, and waiting until you come up to him, you give up the pins, and mark down 1000 in your book; observe that he counts them, and let him proceed. The object of marking the ground, is in case of afterwards losing a pin, you may be the better able to ascertain where the error occurred.

EXAMPLES FOR PRACTICE.

2. Make a plan, and find the area of a square field, whose side is 1043 links. Area 10a. 3r. 20p.

3. Required the area and plan, (on a scale of two chains to the inch,) of a square enclosure, whose side is 675 links. Ans. 4a. 2r. 9p.

4. How many yards are there in a garden, each side measuring 215 yards? Ans. 46225 yards.

5. Bring the 46225 yards in the last example, into acres. Ans. 9a. 2r. 8p. 3yds.

6. What must be paid to a man for grubbing a square piece of wood, measuring 20 rods each way, at 1s. 6d. per rod. Ans. £30.

RECTANGLE OR PARALLELOGRAM.

The next figure to which I would call the attention of the pupil, is a rectangle, for a description of which, and method of plotting it, see problem 3rd, page 9.
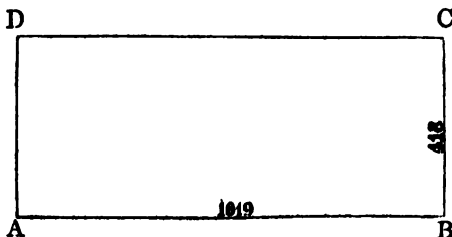
Let it be required to measure and plot the above field.

Proceed as in example 1st, by measuring from A to B, suppose 1019, or 10 chains 19 links; thence from B to C, 418, or 4 chains 18 links. To find the quantity, multiply the side A B, by B C, thus :—

$$
\begin{array}{r}
1019 \text{ A B} \\
418 \text{ B C} \\
\hline
8152 \\
1019 \\
4076 \\
\hline
4.25942 \\
4 \quad * \\
\hline
1.03768 \\
40 \\
\hline
1.50720 \\
\hline
\end{array}
$$

Ans. 4a. 1r. 1p.

EXAMPLES FOR PRACTICE.

2. Plan and calculate a parallelogram, whose sides measure respectively 854, and 632.†   Ans. 5a. 1r. 23p.

3. A hop ground in the form of a rectangle, measures on its opposite sides, respectively 2760, and 1685, required the contents. And what would be the expense of digging, at 12s. 6d. per acre.   Ans. 46a. 2r. 0p.
Expense of digging, £29 1s. 3d.

4. Enclose a piece of land for quarrying, in the form of a parallelogram, whose side A B, shall measure 124 yards, and B C 76 yards. Quere, how many square yards therein, and what is the value at £230 per acre ?
Ans. 9424 yards, or 1a. 3r. 31p. 16¼ yards.
Value, £447 16s. 8¼d. $\frac{19}{121}$.

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* Surveyors seldom put down the 4 and 40 in multiplying, but this is unimportant.

† Unless otherwise expressed, it may be taken for granted, that the figures mean *links.*

TRAPEZIUM.

This figure more frequently occurs than any other, it being an irregular four-sided figure; and those who have followed surveying as a business, will, I am sure, bear me out in saying that irregularity appears to have been the study of those who originally marked out enclosures.
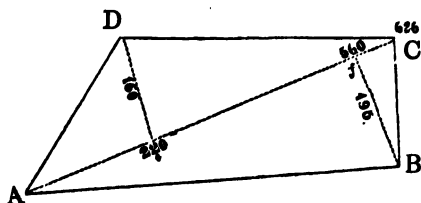
Let us imagine a field of the above form. The system of measuring it, usually taught in schools, has been by the help of the cross staff; and which system I will first explain, the pupil carefully comparing the remarks with the figure.

The surveyor would direct his chain man from A towards C, and when he had proceeded until he considered himself nearly opposite the point D, he would place the cross staff against the chain, and so direct it that he could see, through one of the sights or grooves, the points or ⊙s A and C; and without moving the staff, also through the other sight or groove, the ⊙ D, which place on the diagonal, would be considered the true place for the perpendicular D e. But it is not at all probable this would be attained the first time; he must either advance or recede along the chain, until he ascertains the spot exactly.

Noting down on his sketch or field book the number of chains and links (220), he would here leave a mark, and continue along the diagonal until he arrived opposite the point B, where he would proceed as before, making a note of the spot (560 f), and leaving a mark, he would finish measuring the diagonal A C, which, in this example, is 626. He would now return to ⊙ f, and

measure the perpendicular f B, note down the length
195, then proceed to e and measure the perpendicular
e D 160.

To calculate figures of this description, add the two
perpendiculars together, divide the sum by two, and
multiply the diagonal by the quotient, thus :

$$
\begin{array}{l}
160 \perp e \text{ D} \\
195 \perp f \text{ B} \\
\hline
2)355 \\
\hline
\quad 177.5 \\
\quad 626 \text{ diagonal} \\
\hline
\quad 1065\theta* \\
\quad 3550 \\
10650 \\
\hline
1.11115\theta \\
\hline
\quad .44460\theta \\
\hline
17.78400 \\
\hline
\end{array}
$$

Answer, 1a. 0r. 18p. nearly, the decimal exceeding 5,
being .78400, it may be considered equal to a perch.

This system of measuring four-sided figures has
been adopted for years; but unless, as in the case
before us, the enclosure be small, and the perpendiculars
very short, I would not recommend it; and for this
reason, that little, very little, dependence can be placed
on the correctness of the cross staff in ascertaining the
right angle ; and to inexperienced persons much time is
lost in adjusting it.† True, the quantity may be easily
computed, but ease and expedition avail little if that

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* This cipher is cut off on account of the decimal .5 in the half
sum of the perpendiculars.

† A theodolite would certainly accomplish this, but how few
farmers or stewards possess one.

quantity be incorrect, and in too many cases such is the fact. Again, it frequently occurs that some of the fences are irregular, and it then becomes necessary to measure such fences, and take the offsets, so that little time is saved. Objecting, as I do, to the cross staff, I would advise the pupil to adopt the following method, the advantages of which he will perceive as he progresses.

TO MEASURE A TRAPEZIUM BY THE CHAIN ONLY.

Take the last figure as an Example. Begin at A, measure towards B, thence to C, D, and so on to A. Having thus taken each side, it becomes necessary to have a diagonal, in order to plot the work, which may be done, by measuring either from A to C, or from B to D, for by this method of measuring, the field must be plotted in order to compute the area, to do which proceed thus :*

Draw the line A C, at pleasure, for a diagonal, and from your scale set off the length thereof, 626. Then with one foot of the compasses in ⊙ A, with the length of the line A B 588 as a radius, describe an arc; and with one foot of the compasses in ⊙ C, and the length of B C 210 as a radius, cut the former arc in B; draw the lines A B and B C. In the same manner describe the arcs C D 430 and A D 274, draw the lines and the field is complete.
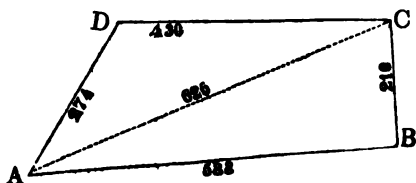
* Many object to this system on account of being obliged to plot the field, and the necessity of having instruments. I would observe that a neat pair of compasses and a small plotting scale may be purchased for a less sum than a cross staff; and the steward having once planned the field in his farming book, it becomes a useful document. The use of mathematical instruments was once reckoned almost the acquirement of a magician; but thanks to the extension of mechanics' institutions and other means of obtaining knowledge, accessible to all, there need be but few persons ignorant of their use.

This may now be calculated, as before, the perpendicular being easily ascertained by the compasses and scale, which the teacher may explain in a few minutes; place one foot of the compasses in ⊙ D, and with the other foot sweep an arc so as to touch the diagonal without crossing it; measure this radius on the scale, and it will give the length of the perpendicular *e* D; do the same at B; and you will have the perpendicular *f* B. In this example they will be 160 and 195, as in the dimensions taken by the cross staff.*

But as there may be cases where immediate calculation is required, and no opportunity of plotting the work, recourse can then be had to the cross staff, or to the offset staff, which latter may be as safely used, if care be taken. Thus, in measuring the trapezium before us, as the perpendiculars are not long, the surveyor might find the place on the chain where to raise those perpendiculars by laying his offset staff thereon, pointing it towards D, and moving it either right or left, until at right angles with the chain; the like with the other perpendicular to B. Offsets are taken in the same manner, which will be fully explained hereafter.

Below are examples for practice, both with and without the cross staff.

1. A four sided figure, measured by the cross staff; the dimensions as in the sketch, the pupil is required to plot the same on a scale of 2 chains to the inch, and to find the contents.
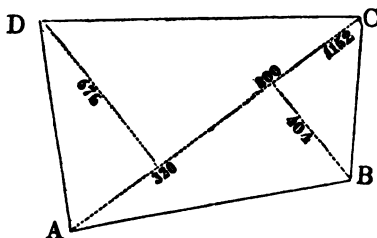
Ans. 5a. 2r. 23p.

2. The same field measured without the cross staff would be from A to B 895, from B to C 533, from C to D 1010, from D to A 654, with a diagonal from A to C 1152. Proof, 1092 from B to D. The calculation would be the same. The pupil is required to plot it thus.

NOTE.—If the respective opposite sides do not differ *very considerably in extent*, the area may be found sufficiently correct by adding the two opposite sides A B and D C together, take the half, and the same with the sides A B and B C; multiply the two half sums together, and the product will be the area.

```
     533              1010
     654               895
    ____              ____
  2)1187            2)1905
    ____              ____
     593               952  mean length
    ====               593  mean breadth
                      ____
                      2856
                      8568
                      4760
                     _____
                    5.64536
                    _____
                    2.58144
                    _____
                   23.25760
                   ========       Ans. 5a. 2r. 23p.
```

This will occasionally save the trouble of plotting the field.

3. Required the plan and contents of a field of the following dimensions :—

A to B 1092	Diagonal from A to C 1112
B to C 508	Proof from D to B 1050
C to D 852	
D to A 475	Ans. 4a. 2r. 16p.

offsets exceeding 100 links were not sanctioned by the Commissioners, and justly so; how much more, then, ought angles of eight and even ten chains, which are, in fact, merely offsets taken by the cross staff, to be discountenanced.

TRIANGLE.

To measure a field in the form of a triangle A B C.
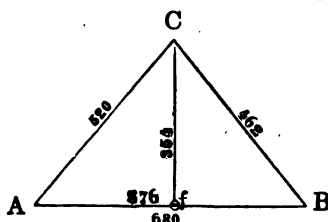
Measure each side separately; and to plot the same, set off A B its proper length, then with the radius B C 462, and B as a centre, describe with your compasses an arc at C. With the radius A C 520, and A as a centre, cut the arc at C; draw the lines A C, and B C, and the triangle is complete. This is, in fact, but the half of a trapezium, as in the example, page 16; the lines, A C, form a triangle, as do also A C B.

If measured by the help of the cross staff, you would proceed exactly the same as in the example just quoted, that is to say, beginning at A, and measuring towards B, you would ascertain when at right angles with C, there leave a mark, and continue to B; then return and measure the perpendicular *e* C, which will be found to be 354.

The area is found by multiplying the base by half the perpendicular, thus :—

2)376	680 base A B
——	188 half perpendicular *f* C ´
188	——
	5440
	5440
	680
	——
	1.27840
	——
	1.11360
	——
	4.54400

Ans. 1a. 1r. 4p.

22

2. Required the plan and area of a piece of ground, the three sides of which measure respectively 940, 650, and 830. **Ans. 2a. 2r. 21p.**

3. In measuring a triangle, I find the base 2784, the perpendicular 986, falling at 1845 on the base, required the plan and contents. **Ans. 13a. 2r. 36p.**

4. Required the area of a triangle, whose three sides are respectively 22—38—33 rods; and the expense of trenching the same at 2s. 3d½. per rod. Ans. 361 rods.
Expense of trenching, £41 : 7 : 3½.
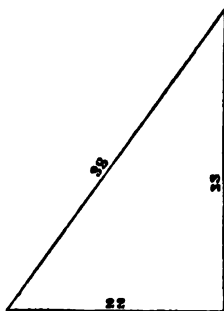
Scale, 20 rods to the inch.

The generally irregular form of fields often compels the surveyor to use many apparently unnecessary lines, and to raise several geometrical figures in one enclosure; these principally consist of triangles, and trapeziums; in the latter, he must be careful always to connect the work by diagonals, when surveying without the cross staff, or of course he would be unable to plot the work, as for example:—In the subjoined field, suppose having measured each side with the intention of making a plot of it,—without a diagonal you would be unable to do this, not knowing what angle either line would form with the other; for having drawn the line A B 420, and wishing to draw B C 200, you would be uncertain whether it

made a right, acute, or obtuse angle, that is, whether it should incline thus—

or thus
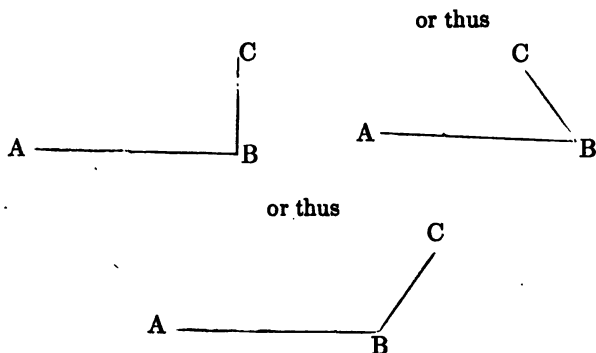
and the same with each line respectively. But by having a diagonal from A to C, or from B to D, the angle or bearing is given; and the figure is then easily drawn. See the instructions for drawing a trapezium, page 18.
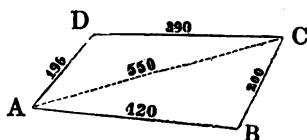
Before we proceed to the method of taking offsets, it will be better to give a few examples of irregular fields, with instructions for measuring them.

PENTAGON.

To measure the following pentagon, or five-sided field.
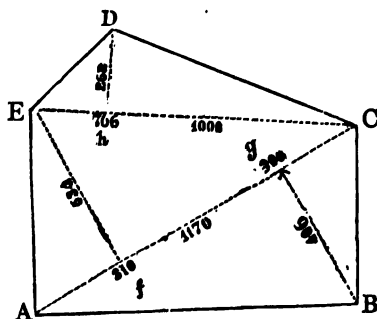
Now, provided these fences be straight, that is, no off-set is required, and it is intended to measure the field with the help of the cross staff, it would be well to begin at ☉ A, and proceeding towards C, ascertain when you are at right angles with E, which, in this case, will fall at 310, here leave a mark; * enter the 310 in your field book, or rough sketch, and continue towards C, observing when at right angles with B; enter the number of links in the field book, leave another mark, and go on to C. Count your pins, and the odd links, (remembering the observation respecting the links, in the note to page 13,) ascertain if the number of pins your chain-man has, correspond with yours, so as to make up the 10, and enter the length of line A C (1170) in the field book.

From C now proceed towards E, observing the right angle for D, as in the other cases. Having carefully entered the ☉ 766, and the length of line C E, and given up your pins, it now remains to measure the perpendiculars.

* The marks, or ☉s usually made by surveyors, consist of small hazel, or other sticks, about 4 feet long, slit at the top, so as to receive a little piece of white paper, with the number of links marked on them, at which they are placed; that is to say, on this diagonal, the first ☉ would be marked 310.

Begin at 766, the ⊙ in line C E, and measure to D, enter the length (268,) and deliver up the pins; this will give the triangle C D E. Return to E and measure to the ⊙ 310, enter the length (534,) &c., and go to the 2nd ⊙, on line A C (900,) and measure to B. Thus, will the trapezium A B C E be formed. And on this principle, fields of almost every variety of shape may be measured.

To calculate the foregoing, add the two perpendiculars E *f* and B *g* together, divide by 2 and multiply by the diagonal, leaving the product in links. Then multiply half the perpendicular D *h* by C E, (or *vice versa*) add the two products in links together, and reduce as before. The area will be 6a. 3r. 15p.

The same figure, measured without the cross staff, would be done by beginning at A, and proceeding to B; thence to C, and so on around the field making a separate line for each station. Now, in order to plot this, it becomes necessary to have two or more diagonals, one of which may be taken from A to C, or from B to E; the other from A to D or from B to D. Suppose the diagonals be from A to C, and from A to D; as in the following field book and plan.
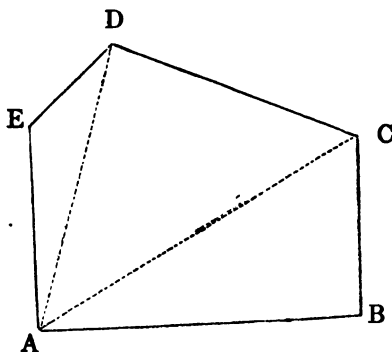
Diagonal fr.	915 D	to A	406 ⊥ B 636 ⊥ D	2)164 ⊥ E
			——— 2)1042	——— 82 915
Diagonal fr.	1170 A	to C	——— 521 1170	——— 410 82 738
fr.	624 · E	to A	36470 521 521	——— 75030
fr.	350 D	to E	6.09570 Trapezium A B C D 75030 Triangle D E F	
fr.	816 C	to D	6.84600 ——— 3.38400	
fr.	486 B	to C	15.36000 ═══════	
fr.	994 A	to B	Ans. 6a. 3r. 15p.	

To plot the foregoing by the field book. Draw the diagonal A C, at pleasure, set off by your scale the exact length (1170,) then with the distance A B (994,) and one foot of the compasses in A, describe an arc to the right hand; again with the radius B C; and C as a centre, intersect the arc at B; draw the lines A B and B C. Now with the length of the diagonal D A (915) for a radius, and A as a centre, describe an arc, and with C D (816,) and C as a centre, cut that arc in D, this will *fix* the line C D. For the sides D E A describe arcs in a similar way at E, draw the lines, and the figure will be formed.

To calculate the area proceed as in the triangle, page 21, and trapezium page 17.

What is the area of a field of the following form and dimensions, surveyed with the chain only?
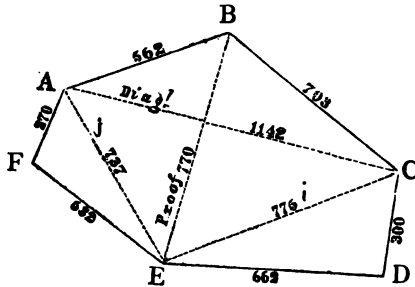
The lines A E and E C are not *absolutely necessary* for the construction of the figure, for the triangles A E F and E C D might be struck off as in the last example; but, as the trouble of running a few chains is very little, and the certainty of having your work correct is every thing, you should never hesitate getting such good proof lines.

This field, it may be acknowledged, might be more correctly measured by the cross staff, than many others, with the addition of proving the work by line E B; for the perpendicular E *h*, being 490, is more than could with safety be trusted to the cross staff alone; and therefore E B would act as a check on the work.

CALCULATION.

Trapezium A B C E.
278 Perp. B *g* ⎱ found as
490 ,, E *h* ⎰ in p. 19.
2)768
————
384
1142 Diagonal A C
————
768
1536
384
384
————
4.38528
————

Triangle E C D.
775 base E C.
125
————
3875
1550
775
————
96875
————

2)250 D *i*
————
125
════

c 2

Triangle A E F.

```
        737 base E A
         72        2)144 Fj.

       1474            72
       5159            ——

      53064
      96875
     438528
      ——————
      5.88467
      ——————          Area 5a. 3r. 21p.
      3.53868
      ——————
     21.54720
      ══════
```

ON MEASURING OFFSETS.

Having given a sufficient number of examples for measuring fields of irregular form, we will now proceed to the system of measuring offsets. These are required where the hedge is not straight from point to point, as in the following figure. Supposing this fence to form one side of a field, it must be measured by getting a line as near as possible to the hedge, as A B.
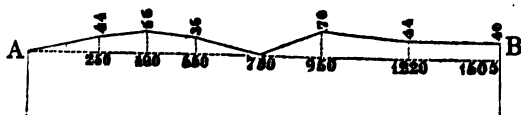
Beginning at A notice the first irregularity in the fence, and with your link staff, ascertain when at right angles with it on the chain, which here is at 250; measure with the staff from 250 to the angle in the hedge, insert the result (44) in the field book as below, or in a sketch as above; then proceed with the chain line until you arrive at the next curvature, viz. at 400, measure the offset as before, note it, and continue the line to the next. After observing this, go on to 750, here you find the hedge and chain meet, so insert a cipher in the field book, and thus go on to the end of

the line 1505, at which point there is an offset of 40·
To plot them you have but to lay down your scale, draw
the line A B, and with a fine needle, dot off the different
places where the offsets were taken, as 250, 400, &c. &c.
then turn your scale perpendicular to the line A B ; and
at each place mark off the respective offsets, right or
left of the line, as they occur; in this case they are all
on the left. It is better to design the fence as you
proceed.

Form of a field book for the Offsets on the opposite
page :—
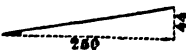
40	1505 to B
44	1220
	1000
70	950
0	750
36	550
55	400
44	250
0	
from	⊙ A

NOTE.— In making a field
book a surveyor usually begins
at the bottom of the last page,
and so works upwards.
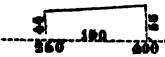
Now, as to the calculation, there are various ways ;
for the present we will confine ourselves to the simple
method of computing by triangles and trapezoids, which,
although occupying many figures and much time, is very
correct, and the only method when the work is not
plotted.

The rule for computing triangular offsets is to mul-
tiply the base by half the perpendicular, and

Small trapezoids, by adding the perpendiculars to-
gether, dividing that sum by 2 and multiplying the
quotient by the base; but, where there are many
offsets, we usually defer taking half the sum of the
perpendiculars until we get the total of the offsets, and
then divide by 2 ; this, it will be perceived, saves many
figures.

Observe, the first offset forms a *right-angled* triangle, therefore, multiply the base 250 by the ⊥ 44.

```
       250
        44
      ────
      1000
      1000
      ─────
     11000
     ═════
```

The next is a trapezoid, that is, a four-sided figure having two of its sides parallel; this is calculated by adding together the two perpendiculars and multiplying by the base; to find this, subtract

```
   400
   250
  ────
   150
  ════
```

```
        44
        55
       ──
        99
       150  base

      4950
        99
     ─────
     14850
     ═════
```

The next is similar 550
                    400
                   ────
                    150 base
                   ════

```
        55
        36
       ──
        91
       150
      ────
      4550
        91
     ─────
     13650
     ═════
```

Then follows another triangle 750
                              550
                             ────
                              200
                             ════

```
        36
       200
      ────
      7200
      ════
```

```
Another triangle ..  950              70
                     750             200
                     ───          ──────
                     200           14000
                     ════          ══════

                                      70
A Trapezoid ....    1220              44
                     950             ──
                     ───             114
                     270             270  base
                     ════          ──────
                                    7980
                                     228
                                  ───────
                                   30780
                                   ══════

                                      44
                                      40
A Trapezoid ....    1505             ──
                    1220              84
                    ────             285  base
                     285           ──────
                     ════            420
                                     672
        11000                        168
        14850                    ───────
        13650                     23940
         7200                     ══════
        14000
        30780
        23940
      ────────
    2)115420
      ────────
       .57710
            4          Answer 0a. 2r. 12p.
      ────────
      2.30840
           40
      ────────
     12.33600
      ════════
```

2. From the following sketch and field book, plot and calculate the same.
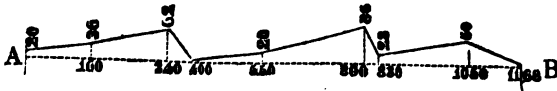
○	1168
50	1050
23	830
86	800
20	550
0	400
62	340
36	160
20	⊙
From	⊙ A

Answer 0a. 1r. 28p.

3. Plot on a three chain scale, and calculate the fence from the following field book :—

22	1026	to B
10	900	
50	722	
84	500	
33	260	Answer 0a. 2r. 0p.
95	170	
0	⊙	
From	⊙ A	

4. Required the content of a rough piece of ground adjoining the field below, and which I intend to have trenched and laid into the same, and what will be the expence thereof at 6d. per rod?

	rods.	a.	r.	p.
	160 =	1	0	0
	40 =	0	1	0
	20 =	0	0	20
6d.	½)220 =	1	1	20
	2,0)11,0 s.			
	£5 10			

Area   1a. 1r. 20p.

Expense £5 10.

It frequently happens that the surveyor, in measuring even a single field, finds it more convenient to commence or terminate his line in the adjoining field, and probably, from the very crooked nature of the fence, to cross it two or three times; this more especially occurs where the boundary is a dike, or a small rivulet:—

Offsets on the left of the line :—

			Triangle A *a b.*		*a b c d.*	
0	1345	to B		140	32	300
32	1308			32	30	140
0	1160			—	—	—
50	1052			280	62	160
	1000			420	160	—
	985			—	—	
	957	23		4480	3720	
	800	20		9920	62	
	642		66	12540	—	
	538		70	9920	9920	
80	414			8750	—	
30	300			5920	*c d e f.*	
32	140			—	30	414
0	⊙			2)51530	80	300
From	⊙ A			—	—	—
				25765	110	114
				—	114	===
				1.03060	—	
				—	440	
				1.22400	110	
				===	110	
					—	
					12540	

e f g	Triangle *h i*	Triangle *i j*
538	1160	1345
414	985	1160
—	—	—
124	175	185
80	50	32
—	—	—
9920	8750	370
===	===	555
		—
		5920
		===

Offsets on the right of the line :—

g k l	k l m n		m n o p		o p h
642	800	70	957	20	985
538	642	66	800	23	957
——	——	——	——	——	——
104	158	136	157	43	28
70	136	=====	43	=====	23
——	——		——		——
7280	948		471		84
21488	474		628		56
6751	158		——		——
644	———		6751		644
———	21488		=====		=====
2)36163	=====				
.18081					
———					
.72324					
———					
28.92960					

Answer $\begin{cases} 0a. & 1r. & 1p. & \text{on the left.} \\ 0 & 0 & 29 & \text{on the right.} \end{cases}$

What is the area of the offsets, right and left of the following ?
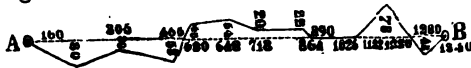
From the following field book, construct the figure, and find the quantity on each side of the chain line A B.—
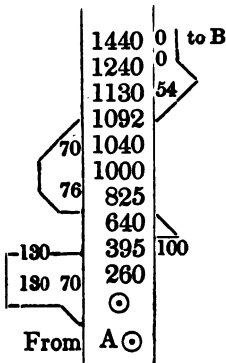
Answer—
Offsets on the left   2r.   2p.
Do.   do.   right 0   26

We will now commence measuring fields with the offsets annexed; that is to say, not the mere *geometrical figure* as heretofore, but the *exact form* as below. The first few examples being explained, the pupil must contrive to resolve the others by himself.

What is the area of a field of the following form and dimensions?
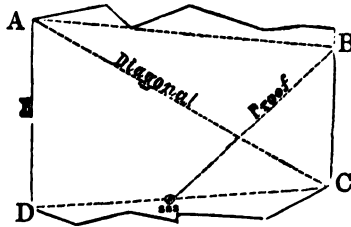
Proof from	533 B	to 388 C D line 6	60 40	388.	
Diagonal from	795 A	to C line 5	60 0 from	170 ⊙ C	line 3 —go westerly
0 0 0 from	442 220 ⊙ ⊙ D	to A line 4	0 0 from	322 ⊙ B	to C line 2 turn right
0 33 30 60 40	-708- 606 487 388.	to D line 3 continued.	47 52 28 68 0 44 0 from	-714- 636 560 338 240 182 ⊙ A	to B line 1 go easterly

* In lines the first and second, on the fences, a small mark is
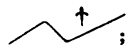
This field can be measured either with or without the cross staff; as there are several offsets, I have adopted the latter plan, and have measured each side. See the Field Book, from which book it can be easily plotted, thus:

Set off the line A B its exact length, viz., 714 without regarding the offsets for the present.

With the radius B C (322) and centre B describe an arc to the right.

With the radius A C, the diagonal (795), and centre A cut the former arc in C, and this will give the true position of the triangle A B C as described in page 23. Now with the radius C D 708, and centre C, strike an arc to the right, and nearly parallel to line A B, and with radius D A, 442, and centre A, intersect that arc in D, thus will the triangle C D A be formed.* It will be observed that there is still another line, the proof; this, as far as the actual construction of the figure is concerned, is unnecessary, but I invariably adopt it, as it forms a check on the work, and occupies but little time either in the field or in the office. If the work be correct, lay the plotting scale from B to ☉ 388, line C D, and it will give the distance 533 exactly; but should it measure either more or less, the work is somewhere incorrect. The trapezium being formed, proceed to lay down the offsets as explained, page 29.

Should it however be necessary or desirable to use

placed thus ╱‾╲╱ ; observe that it is used to show to which field the fence belongs; and this is a point on which you must be careful; the first and second fences are shown to belong to the adjoining fields, the third and fourth to the field you are measuring. There is some difficulty in ascertaining this, the custom of the country varying much. In general, however, we consider the hedge and ditch to belong to the field where the hedge is protected by the ditch, and so measure five links beyond the *stem;* on the principle of the hedge having been so planted as to give the owner an opportunity of attending to its growth on the outer side, and at the same time of protecting it from depredation by cattle.

* This is merely a repetition of the rule for constructing a trapezium, but as we are now in what may be called actual field practice, I thought it as well to give the instructions again to facilitate the work, my desire being to explain every rule fully, and to render it familiar to the pupil. — "Repetition is better than obscurity."

the cross staff in measuring the foregoing figure, the same lines may be used with the addition of the two perpendiculars from the diagonal, see page 16.

It may be as well to observe, before we proceed further, that there is no particular point for a surveyor to begin his work in the field, he must let his judgment direct him, seeking the most unobstructed view of the ground, and the clearest sight from corner to corner. In the field before us, he might as well have begun at ⊙ D, or B· or C. The best way is, on entering a field, to take a good view of it, determine how you intend to measure it; observe if there are any conspicuous marks at or near the corners, such as a tree, post, &c., if not, direct your chain man to take sticks, such as described in the note, page 24, and place one at each corner, or at such place that it may be seen by you in approaching it from the last station. Frequently it is necessary to set up several of these sticks in a straight line, from point to point, the inequalities of the surface of the ground preventing one object being seen at a long distance. When this is the case, great care must be taken to keep the sticks upright, and so exactly straight, that if twenty were erected none should be seen either to the right or left of another.

Get always as near as you conveniently can to the hedge, so as to have the shortest offsets possible.

The last figure will be calculated as a trapezium, and the offsets as in page 30. The area is 3a. 0r. 35p.

It will hereafter be shown, that there is a much more simple method of computing offsets by the parallel ruler.

$$392 \brace 290 \text{ Perpendiculars found as in p. 19.}$$

2)682

341
795 Diagonal A C.

1705
3069
2387

271095
52055 Sum of Offsets.

3.23150

.92600

37.04000 Area 3a. 0r. 37p.

Offsets on line A B.

```
  240      338      560     68     636     28
   44      240      338     28     560     52
 ────    ────     ────    ──    ────    ──
  960      .98      222     96     .76     80
  960       68       96            80
─────    ────     ────           ────
10560      784     1332          6080
 6664      588     1998          ════
21312     ────     ────
 6080     6664    21312
 7722     ════    ════
10200                          714      52
21800                          636      47
 8910                          ────    ──
 7497                           .78      99
 3366                           99
─────                          ────
2)104111                        702
─────                          702
52055                          ────
                               7722
                               ════
```

Offsets on line C D.

```
  170      388      60      487      60
   60      170      40      388      30
─────    ────    ────     ────    ──
10200      218     100      .99      90
═════              100(═)    90     ══
                   100
                  ─────
                  21800             8910
                  ═════             ════

  606                30             708
  487                33             606
─────              ────            ─────
  119                63             102
   63              ════              33
─────                             ─────
  357                              306
  714                              306
─────                             ─────
 7497                             3366
 ════                             ════
```

Examples for Practice.

Required the plan and content of a meadow from the follow field book.

	302	to A
	150	20
from	817.	go north

a lane
—|823—|-10\
817.
350 | 22
200 | 17
from | 372 | go easterly

| Proof | 476 | to 372 line 3 |
| from | 500 | line 1 |

—|382—|-0
372.
184
from | 806 | 0 go south

| Diagonal | 592 | to 806 B |
| from | 817 | |

806. |0 B These dots sig-
500.   nify stations.
320
from | ⊙A |0 go westerly
—|-18*-|0—

Area 2a. 3r. 36p.

It is required of the pupil to plot and calculate a

* The station A is placed 18 links from the hedge.

field, in the above form, from the following field
book:—

405. 0 | to A
⊙ 0 |
from ⊙1566 D   4

1566. 0 10 to D
1430 30
1270 40
Proof | 833 | to D   1100
from | 700 | line 1   1055
                          1000
Diagonal | 990 | to 700 line 1   935   3
220   862
                          750
from | ⊙C   720
                          610 40
335 | to 350 F   550 30
142 | 0   480 30 40
from | 355 | E   5   410 50 60
                          360 33 43
                          350. 0
                          250 0
                          150 0 10
                   from ⊙ C

560 | to C
396 | 70
355• | E   2
272
from | 1375 | outbounds   •

1375 | to B
1182
1176 | 20
1000
20 764 | 52 outbounds   line 1
700• | for diagonal
280 | 107
182 | 20
⊙
from | ⊙A | go easterly
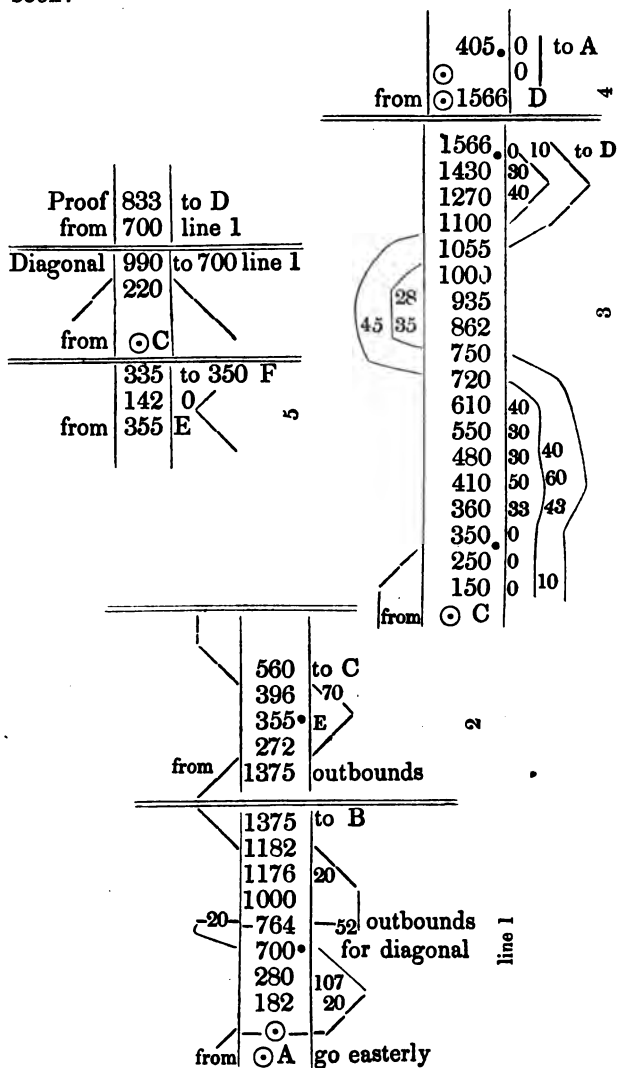
OBSERVATIONS.—The fences of this field being very irregular, the surveyor would find it more convenient to trespass a little on the adjoining property, in order to avoid long offsets. Therefore, having first perambulated the fences, and leaving ☉s at A B C D, he would proceed as in the field book.

In going from B to C, a ☉ is left at E; and from C to D, another is left at F, for the purpose of taking the offsets adjoining. The stream is ten links wide, one half of which is supposed to belong to the field. The method of plotting and computing this figure is precisely the same as the previous ones, it being understood that no part of the ground outside the fence, is to be included in the area.

The pupil is required to ascertain the contents, exercising his own judgment as to the simplest means of so doing.

<div align="right">

Answer   7a. 0r. 2p.
½ Stream 0   0 11
Total 7   0 13

</div>

Since writing the foregoing, I have been employed to measure the following property, which forms so good an illustration of my remarks on the general inutility of the cross-staff, that it may be well to insert it. This enclosure is a brick-field, and from the circumstance of its being excavated in almost every part, particularly where so shown in the sketch, it would have been impossible to get a diagonal from corner to corner, with its respective perpendiculars. I therefore measured each side, took the diagonal from the only points available, and left it to the proof line to test the correctness of the work.

The pupil should plot the same from the subjoined field-book; and also find the area.

Proof   593 to 424 [2]

22

fr. 400 [4]

Diagonal   541 to 400 [4]

522

fr. 451 [1]

1180

TURNPIKE ROAD   **TO SANDLING.**

17   1136   5

17   980   5

50   40   835

760 to 40 [1]

555

* A little * mark of this kind is usually put to denote to which side the fence belongs   25   400   for proof.

25   300

25   200

30   130

40

fr.   590

line 4

R. LUSHINGTON, Esq.

Wall.   609   5

590   5

498

458   0

248   0   Lodge

215   0

line 3

---

215   0   Cot.

150   0

20 0 Lodge 20 0   100   0   line 8

15   57

20   Mr. Sutton.

fr.   815 [2]

20   0   840   25   Foot Path.

815

30   0   797

105 + 50   0   740

25 + 30 0   550

Lodge   30 0   512

135   424   For proof—Gate-post marked.

Sold   408

135   149   25

23

fr.   625

line 2

650

From   625   30   Thornhills.

Sold   612

23   490

486   30   Mr. Sharp

20   475

Mark on post   451

81   30

40   30

40 / 40   Mr. Russell   line 1

fr.   ⊙ A   10 +

Make a map and calculation of a Meadow and Buildings from the following field book.

				820	To the Hills
				800	
	65			775	
	77			740	
110	94	70	5	515	
		Yard		450	line 3
		75	4	418	
	Road	Yard	2	384	
	73	36	2	344	for Diagl.
			44	315	
			40	246	
			102	60	
			fr.	230	line 2

			400	Road
12	18		382	
61	35			
	70		340	
	80		260	
			230	line 3
	95	35	195	
22		12	136	
	11		88	
From the Bay.	Marine House.	fr.	811	

Proof   428   to 811

fr.   344

Diagonal   535   to 344

fr. ⊙   A

		296	to A	5	811
30	15	114		fr. ⊙ A	323
	fr.	800		5	12
			Mr. Temple.		line 1

Field in St. Margarets, the property of James Temple, Esq. sen

From the following field book, construct a plan and find the area.

Diagonal	872	to 458 ²		463		W. Pilcher, Esq. line 2
from	360	¹		458		
				440	19	
	656		fr.	1070	¹	go N.W.

TO THE VILLAGE.

	621	10	1078	6	
Proof Footpath	590	10	1070		
	550	4	1060	20	To Kingsdown.
	475	6	1000		
	467	×360 ¹	940	60	
fr.	662	³	815	108	
			725	139	
Stack Yard	459	to 67	515	Footpath	line 1
	405	0			
	370	0	360	for diagl.	
		55			
		55			
Line 4	350	0	350	3	Farrier.
	320	60	40─320	3	
	88	0 65	STACK YARD.		Mr. Tucker. From the Village.
fr.	1061	³ To Dover. To Westcliff.	67	16	
line 3	1061	4	FIR PLANTATION.		
	1000	4 Mr. Groombridge.	⊙	20 9 Boundary Stone.	
	662	for proof			
fr.	458	² go parallel with line 1.	fr. ⊙ A	go easterly.	

Meadow.............	5a. 1r. 37p.
Fir Plantation......	0 0 37
Stack Yard	0 0 27
	5 3 21

Meadow in the Parish of St. Margaret's, the property of Wood Pilcher, Esq.

Field book for the opposite plan :—

Proof	628	to D
fr.	420	ı

		° C
Diagonal	775	to 410
fr.	420	ı

	530	0
	503	10 to A
	410	10
	100	50
fr.	1040	° D

	1040.	0 to D
	1000	
	866	44
straight.	613	0
fr.	410	°C go westerly.

	422	15
	410.	14
	200	0
fr.	1000	ı B go north.

	1037	33 *
	1000.	to B
	420	25 63 *
	300	52
	280	23
	150	10
	84	33
fr.	A	go easterly.

* Offsets thus marked on the line signify that they are not at right angles, but are taken as the fence runs.

Two or more Fields together.

When it is required to measure several fields adjoining each other, much time and trouble may be saved by carefully observing the following methods, and adapting them to such circumstances as may occur in the course of practice; the surveyor exercising his own judgment, it being impossible to point out definite methods, the variety and intricacy in the forms of enclosures being so great. Added to this, the uneven surface of the ground often compels the measurer to take quite a contrary course from what it might appear, when plotted, he ought to have taken.

Supposing it necessary to measure the following fields :

these may easily be done by extending the lines A B and C D, which would have been used for either field separately, as far as the limits extended.

Observe,—the line A B as it appears on paper, might have been run closer to the fence; but this was impracticable (or rather inconvenient) on account of the pond in No. 1, and the rough in No. 2. These are impediments which frequently occur, and the example given may prepare the student for such cases in the field.

Beginning at ⊙ A we proceed towards B, observing the offsets as before.

At 420 we cross the fence, dividing No. 1 and No. 2, and mark it as in the field book. It will be well to leave a ⊙ here for a diagonal and proof, and then we continue towards B, exactly as though there had been but one field; the fence from the last offset being straight, we require no more until we arrive at the end of the line.

From ⊙ B 1000 we go on as usual to C 410.

From C turn westerly; and at 613 we again cross the fence separating No. 1 and No. 2: now this fence being straight, it will be needless to measure it for either field, a line being drawn as in the plan being all that is required; finish this line to D, and then line D A as before.

The diagonal may now be run from ⊙ 420 to C, or from A to C; but supposing the hedge of division to be high and thick, it would be preferable to adopt the former, and take a proof from D to A.

These two fields may be plotted exactly as in the previous cases; and had they been divided into three or more separate enclosures, the method of surveying and plotting would have been the same provided the fences were straight.

To calculate the area, I should proceed by disregarding the line A B, for the fence by the pond in No. 1 being straight, I should consider the trapezium of that field composed of the following sides: $e f$, $f g$, g D, and D e, then taking a diagonal, as f D 665 and the 2 perps. 330

332	334
——	——
1330	2)664
1995	——
1995	332
——	═══

2.20780 trapezium
22259 offsets

———

2.43039

———

1.72156

———

28.66240

════════

Offset on line C D.

        1040 length of line
         613 beginning of field No. 1.
        ———
        .427 remr. length of line g D.
          44 offset
        ———
        1708   Offsets on line D e.
        1708   100   410   50   503   10
        ———   50   100   10   410   10
        18788   ———   ———   ——   ———   ——
        5000   5000   310   60   .93   20
        18600   60   =   20   =
        1860   ———   ———
         270   18600   1860

       2)44518
        ———   530
        22259   503
                               ———
                               .27
2a. 1r. 29p. nearly.   10
                               ———
                               270

No. 2.

The same principle occurs here; let the sides be $h\,i$, $i\,j$, $j\,g$, and $g\,h$; then with the diagonal $i\,g$ 717, and the two perpendiculars 400

                408   Offset on line $i\,j$
             2)808   233 distance from i to R
              ———   40 the offset
              404   2)9320
              717   ———
             2828   4660
              404
             2828
            ———
           2.89668
             4660   2a. 3r. 31p.
           ———
           2.94328
           3.77312
          ———
          30.92480

We will now take a small track of land, divided into three fields, the fences of which are irregular.
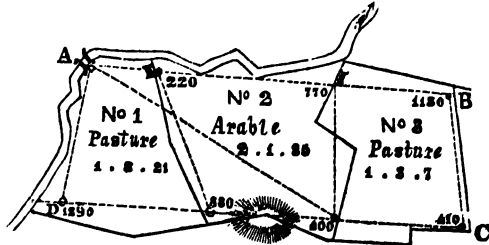
It is not at all probable that you would be able to see distinctly from point to point, without first examining the place well, and fixing on marks if there be any; availing yourself of gates, or gaps in the fence, or placing sticks as before directed; depend upon it the time is not lost which is spent in carefully setting out the work, for, independent of thus finding greater facilities in measuring, it consequently happens that less trouble is required in mapping; and we have a saying, that, "work well set out is half done." I would here suppose that on entering the foregoing property by the bridge, you find a clear view along the stream, through the gates, to the end of No. 3. Consider this as a good line to commence with, and before you begin to measure, walk around the fields, and observe where to place a ⊙ for measuring the fence between Nos. 1 and 2, and the like between 2 and 3, put down sticks in these spots, and also at the point B. At the corner C do the same, then, proceeding towards D, try to get a line as near the hedge as possible: and suppose that in ascending the brow you lose sight entirely of the corner D; it would be better to fix a stick just where the fence makes an angular point on the brow in No. 2, and, standing just behind this, direct your man to place another at the fence between Nos. 2 and 3 in a straight line with ⊙ C, then another at the fence between Nos. 1 and 2, opposite their corresponding stations on line A B, and still straight with C. By the means of these sticks, continue direct to D, where you should place one in such situation that you can get a clear view of A, and be still in a straight line with C.

You may now begin to measure; and having taken the four sides, and lines 5 and 6,* measure a diagonal from A to 400 (3)† supposing it difficult to get one elsewhere. No proof line is required, as the lines 6 and 7 for the intervening fences serve as such; for, after having laid down the trapezium, should the line 6 measure more or less than 416, or line 7 exceed or fall short of 446, then would the work be incorrect; these lines should fit into their respective stations in the same way that the joists of a building fit into the beams; that is, if too long, they would extend beyond the station, and if too short, would not reach it.

Had these fields been measured separately, it would have been necessary to take the four sides of each, besides a diagonal and proof line for each, the advantage of taking them together is therefore very perceptible.

By comparing these instructions with the plan and field book, and by exercising your own judgment in similar sketches, I have no doubt of your being able to survey correctly, and with ease, almost any enclosures with which you are likely to meet.

INSTRUCTIONS FOR PLOTTING THE LAST FIGURE.

The pupil will observe that the diagonal, for the reason before stated, goes from ⊙ A into 400 (³), thereby making the lines 3 and 4 the angle for construction.

Draw the diagonal 906; the beginning of which will be ⊙ A, and the end will be the ⊙ 400 on line 3 or C D. Then with the radius D A (442), and A as a centre, strike an arc downwards (or south) subtract 400 from 1290 length of line C D

400
———
890 and with this radius, and 400 for a centre, intersect ══ the arc at D; thus will the triangle be formed.

---

* Surveyors usually number their lines, instead of lettering; thus, from 1000 (²) to 400 (³) reads, from station 1000 line 2 to 400 line 3.

† I would suggest it as a good plan for a pupil to notice fields as he passes through them in his occasional walks; and devise the method of measuring them in his mind. He will thus habituate himself to the system and acquire a quickness of perception which he will find very useful when called upon to exert his own skill.

Extend the line C D to its full length 1290, which will give ⊙ C, then strike off lines A B and B C, as in the former examples. A little more trouble is thus given, but be it remembered that cases of this kind frequently occur, and the pupil should be prepared for them.

No.	AREA.			
---	Description.	A.	R.	P.
1	Pasture ..	1	3	21
2	Arable	2	1	35
3	Pasture ..	1	3	7
		6	0	23
	Half Stream	,,	,,	32
	Total ..	6	1	15

The following field book is the one I adopted for measuring the foregoing property, and the pupil, by plotting it on a scale, of two or three chains to an inch, and carefully comparing it with the plan, will find the system most easily to be understood, and applicable to the measuring of not only three, but of many fields together.

line 3

Diagl. 906 to 400

260

fr. ⊙ A

		line 3
0	830	
	630	
40	415	
	400	
	396	
36 0	160	
fr.	410	C

line 2

14	410 to C	
fr.	1130	B

Bridge   442 to A

				line 4
16	420	15	1144	Straight.
22	390		1130	No. 8.
10	360	[4]	1000	
43	280			Pasture.
20	220	50	800	
14	140		770	Mark on Gate.
fr.	D	30	650	
		0	550	
		60	500	No. 2.
		20	430	
				Arable.
		0	365	The stream is 30 wide.
		32	255	
			220	

The End.

line 7

496	0
456	to 880
230	44
fr. 220	

line 6

416	to 770 mark on gate	
50	265	
	256	
	246	60
from	400	

16	1390
40	1360
	1290	D
86	1046
	1000
	840
	830	line 3 contd.

Stream

|		line 1
	215	
30	200	No. 1.
25	100	Pasture.
28	50	
0	⊙	Mark on post of Bridge.
fr.	⊙ A	go eastward.

Meadows in the Parish of Ash, the property of Mr. R. Varty.

No proof line is required, as line 5 serves to prove the trapezium A B C D, and line 8, B C E F.

	482	to 560	732	0 to A
			460	
46	440		420	
5	275	s	410	62
35	195		100	40
fr.	623		fr. 1250 D go south.	
	570	to 990 c	1290	0
			1250	D
	500	30	1150	85
	410	0	920	40
7	310	40	740	57
	240	36	690	
	150	5	510	80
		Straight.	200	16
fr.	623		20	20
			fr. 990	C go westerly.
	623		990	C
			560	
6	592	33	410	0
	433	40	Straight.	
	250	8	340	
fr.	1180	go N.E.	fr. 830	B northeasterly.
	972	to 340	1200	0
		Straight.	1800	
0	652		958	34
62	433		830	B
40	290		508	74
40	130		360	0
fr.	460		270	25
			fr. ⊙A	0 go southeasterly

Diagl. | 1288 to B
632
fr. ⊙ | D 1250.

On the opposite page is a field book for the construction of the figure below ; the pupil should plot and compute the same.
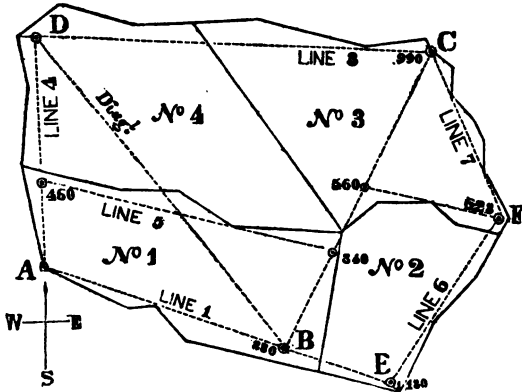
I do not consider any further instructions necessary for plotting this, every part being applicable to some of the previous rules. I have added a plan of the fields, without the lines of construction, and have designed hedges, rails, &c. to give the pupil an idea of making a plain, neat plan.
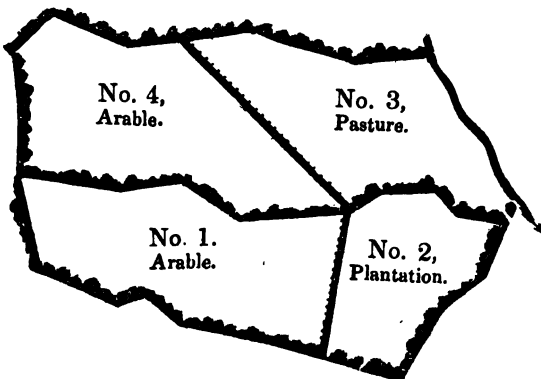
RULES FOR EQUALIZING OFFSETS.

It has been before observed that there are different ways of computing offsets, the one we have hitherto adopted is very safe, but somewhat tedious. I will now proceed to explain the method of calculating crooked fences, by equalizing or reducing them to straight lines by means of the

PARALLEL RULER. This is a very expeditious and correct way of computing, particularly where many fields lie together, saving an immense number of figures, and much time ; for this reason it cannot be introduced at a better place than the present, where, after giving a few examples, a comparison may be made by finding the area of the last four figures by both systems.

Let us imagine the following irregular fence to a field ; it is required to reduce it to a straight line ; that is, to draw such a line, as passing through it from one of its extremities, shall leave an equal area on the one side of the line as on the other.

Erect a temporary line at one end of the fence, as A B.
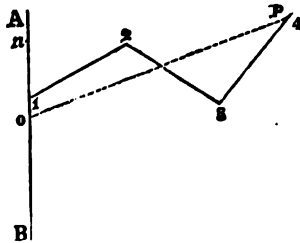
Lay the parallel ruler from 1 to 3* and move the upper part of it to 2 ; with a needle or very finely pointed pencil, mark the line A B as at *n*; this being the place cut by the ruler.

From *n* lay the rule to 4, and bring it down to 3, dot

---

* The angular points of the fence are numbered 1, 2, 3, &c., for the purpose of explanation.

the line A B as at *o*; draw the line *o p* which will be the straight line required.

2. Reduce the crooked fence below to a straight boundary.
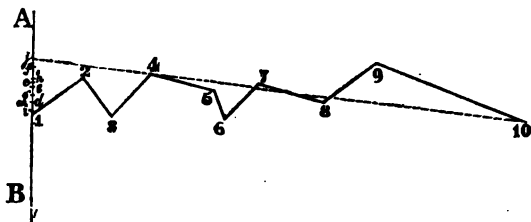
Erect a temporary line at one extremity, as A B.

Lay the parallel rule from 1 to 3, and bring it up to 2; mark the line A B where the rule cuts, as at *c*.

Lay the rule from *c* to 4, and bring it down to 3; mark the line A B at *d*.

Lay the rule from *d* to 5, and work it up to 4; mark the line A B at *e*.

Lay the rule from *e* to 6, and work it up to 5; mark the line A B at *f*.

Lay the rule from *f* to 7, and work it back to 6; mark the line A B at *g*.

Lay the rule from *g* to 8, and work it back to 7; mark the line A B at *h*.

Lay the rule from *h* to 9, and work it back to 8; mark the line A B at *i*.

Lay the rule from *i* to 10, and work it up to 9; mark the line A B at *j*.

Draw a dotted line from *j* to 10, and it will be the fence required, as in the above example.

This, though occupying many words in the explanation, becomes a very simple and easy operation after a little practice.

A further description of the method must be unnecessary; the pupil can copy the following examples, and

draw others for himself. He can also prove any of the former questions by this rule.

No. 3.

No. 4
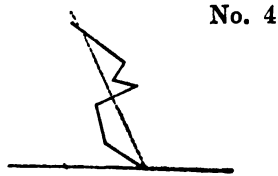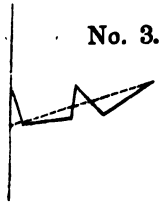
No. 5.

No. 6.

Suppose Examples 7 and 8 represent fields; required the area.

7
1 . 3 . 26

8
2 . 0 . 23
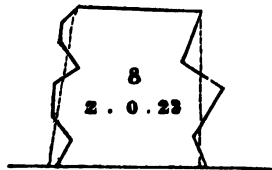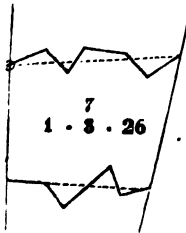
It will be observed that examples 7 and 8 form fields, and from these examples the utility of equalizing the crooked fences may be seen: thus, these fields may now be calculated without any offsets, as trapeziums, by taking the dotted lines for fences; because, these dotted lines have been so drawn, as to include exactly the same space of ground they excluded.

Upon this principle also irregular boundaries between the properties of different individuals may be adjusted,

and a straight fence set out, so that neither may sustain loss.

We will now proceed to the calculation of the plan, page 55, on the principle of trapeziums and offsets, and by the rule for equalizing offsets.

It is not necessary to follow the lines of construction to form the trapezium, these may be drawn where it may be judged most convenient, and likely to give smaller and fewer offsets.

No. 1.

CALCULATED BY THE USUAL METHOD.


```
 206              860    •              N° 1
 342                    640        ×
 ———                              ×      843      70
2)548                      8   r   p
 ———              606    1170    8 . 8 . 8
 274                   294    40 ×
1170                              594
 ———              8
19180
 274                    343   Offsets.      52
 274                     70                540
———                    ——————            ——————
3.20580               24010               2080
 56096                28080                260
 ——————               6480               ————
3.76676               15582              28080
 ——————               2400              ══════
3.06704               35640               360
 ——————               ——————              . 18
2.68160              2)112192             ————
 ══════               ——————             2880
     23    294        56096               360
     30     53        ══════             ————
     ——    ———                           6480
     53    882         594              ══════
     ══   1470          60                 80
          ——————       ————                30
          15582       35640              ————
          ══════      ══════             2400
                                        ══════
```
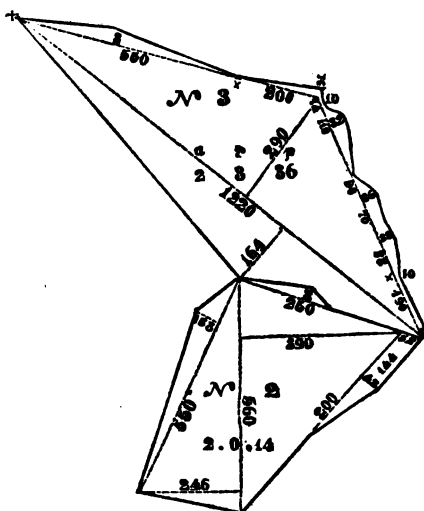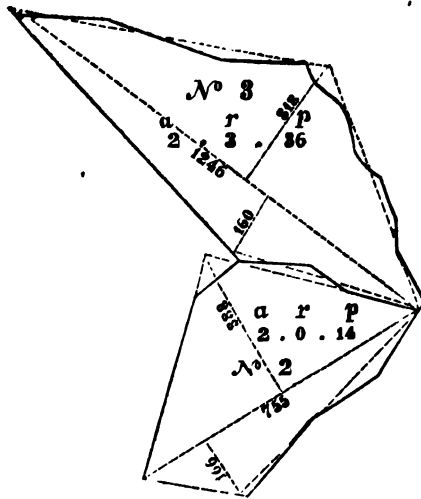
CALCULATED BY EQUÁLIZING THE SIDES.

N° 1

$$a \cdot r \cdot P$$
$$3 \cdot 3 \cdot 2$$

1181	218
319	420
———	———
10639	2)638
1181	———
3543	319
———	
3.76749	
———	
3.06996	
———	
2.79840	

By this method a saving of 121 figures is obtained in field No. 1.

No. 2.

43	43	
200	52	
8600	95	390
13680	144	246
7500		
31900	380	)636
	380	
2)61680	95	318
		560
30840	13680	
		19080
250	550	1590
30	58	178080
		30840
7500	4400	2.08920
	2750	
		.35680
	31900	
		14.27200

No. 2.—Calculated by equalizing the Fences.

$$166$$
$$388$$
$$\overline{}$$
$$)554$$
$$\overline{}$$
$$277$$
$$755$$
$$\overline{}$$
$$1385$$
$$1385$$
$$1939$$
$$\overline{}$$
$$2.09135$$
$$\overline{}$$
$$.36540$$
$$\overline{}$$
$$14.61600$$

No. 3.—CALCULATED BY THE USUAL METHOD.

10	10	33	36	110
18	33	36	90	32
28	43	69	· 3240	220
190	88	70		330
2520	344	4830		3520
28	344			
		32	16	550
5320	3784	10	200	40
3784				
4830		42	3200	22000
3240	.	74		
3520				164
3108		168		290
3200		294		
22000				)454
		3108		
49002				227
7500 deduct		250		1220
		30		
)41502				4540
		7500 offsets out bounds		454
20751				227

276940
20751

CALCULATED BY EQUALIZING THE FENCES.

160	1246	
318	239	
)478	11214	2.97691
	3738	
239	2492	3.90764
	2.97794	36.30560
	3.91176	
	36.47040	

Left column:
563
60

33780

380
72

760
2660

27360
1200
14924
2100
33780

2)79364

39682

Middle columns:
27
14

41
364

164
246
123

14924

12
100

1200

14
150

700
14

2100

Right column:
340
290

)630

315
1209

2835
6300
315

3.80835
39682

4.20517

.82068

32.82720

No. 4.—EQUALIZED.

Diagl.   1248   360
          337   315

         8736   2)675

         3744
         3744   337

        4.20576

         .82304

       32.92160

By this system of equalizing figures, many tedious
calculations are avoided, for it is not only applicable to the
foregoing purposes, but figures of different numbers of
sides may be reduced into triangles and trapeziums;
thus the hexagon, or six-sided figure, page 27, may be
reduced to a triangle with the least trouble, and calculated
as such.
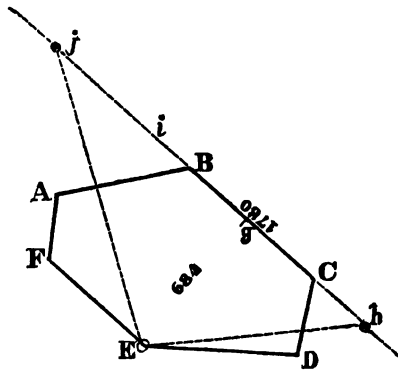
By explaining the above, the pupil will be able to
reduce figures of similar construction; therefore extend
any line at pleasure, as B C, lay the parallel ruler from
C to E, and move it to A, mark where it cuts the extended
line B C as at h; draw the line h E.

Lay the rule from B to F, and work it to A; mark the
line B C, where it cuts, as at i.

Lay the rule from i to E, and work it up to F at j;
then draw the line j E; and the triangle j E h is equal
to the hexagon A B C D E F. This is proved by mul-
tiplying the base j h by half the perpendicular E g, or
by multiplying one by the other, and taking half the
product.

684 ⊥ E *g.*
1720 base *j h.*

13680
4788
684

)1176480

5.88240

3.52960

21.18400

The Pentagon, page 24, reduced to a Triangle.
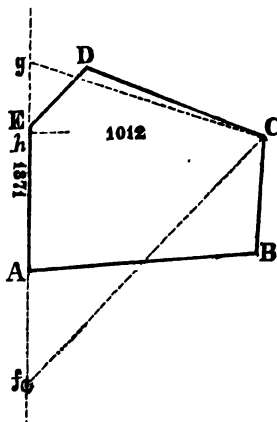
1371 base *g f*   2)1012 ⊥ C *h*
506

     506
8226
68550

6.93726

3.74904

29.96160   Answer, 6a. 3r. 30p.

It is unnecessary to give further examples of this kind; the learner may in fact find examples sufficient by equalizing any of the foregoing figures, or by designing others himself, and proving them by the different methods of calculation. And as I would fain hope that many of the students into whose hands these pages may fall, are actuated by a *desire* to become thoroughly acquainted with the study, I trust that these occasional hints and remarks may not be wholly useless, (and to ensure success) that the master and the learner may travel on hand in hand together.

I have now, I believe, advanced sufficiently far in the system of land measuring to give the learner a correct knowledge of the art to that extent which is required of him. It is not my intention to extend the work so as to conduct him through all the various rules requisite for a professional surveyor; there are already many valuable works published, from which that knowledge may be acquired; and which, should his taste lead him that way, I would recommend him to study.

' The remainder of this treatise will be devoted to sundry examples and explanations more immediately connected with agriculture, such as measuring cants, falls of woods, divisions of fields, &c. together with a few tables which may be found useful to the agriculturist.

To measure Cants.*

Supposing it is required to set out the following field of wheat in acre pieces, or cants, the furrows running from left to right, beginning at A.

1000 links.
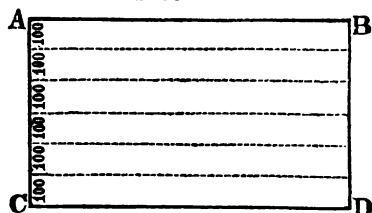
* The word cant is a provincialism much used in Kent and Sussex, signifying a small portion of ground, set out for reaping, mowing, &c.

. ˙This being what is geometrically termed a rectanglé or parallelogram, that is to say, a figure whose opposite sides are equal, and whose angles are all right angles, adopt the following easy RULE.

Measure the length, reduce each cant into links, and divide by the length of the field, the quotient will give the number of links in width each cant must be. In this example I have given the length of the field just 1000. An acre contains 100,000 links, see the table, page 3, and as the field is to be set out in acre cants, we must 'divide thus:

$$\frac{\text{length of field}\big\backslash}{\text{links } 1,000 \, \big/ 100,000 \text{ links in an acre}}$$

$$\underline{100} \quad \text{required breadth of each cant}$$

Then measuring along the fence from A towards C, drive down a stump at the end of each chain (100 links), and the field will be found to contain 6 cants of 1 acre each. Thus is the proportion carried throughout all work of this kind, ten chains or 1000 links in length, by one chain, or 100 links, in breadth making an acre.

| 864	
115	1Acre
115	1Acre
916	1Acre
815	1Acre
100	.r p . 3 . 18

The above field measuring 864 links in length, requires 115 or 116 in breadth to form acre cants, thus:

$$864)100,000 \text{ (115 nearly 116}$$
$$\underline{864}$$

$$.1360$$
$$\underline{864}$$

$$.4960$$
$$\underline{4320}$$

$$.640$$

There are 4 cants of 1 acre each, and a breadth left of 100 links, by which, if the length be multiplied, it will produce 0a. 3r. 18p. for the last cant.

$$864$$
$$\underline{100}$$
$$.86400$$
$$\underline{3.45600}$$
$$18.24000$$

If the field be irregular, and have crooked fences, the following examples may serve for almost all cases.
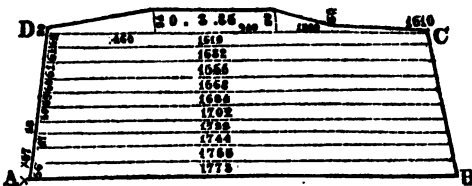
Suppose the above to be a field of turnips to be hoed by the acre; it is required to set off the cants in acres.

Measure from A to B, and observe that A B C are not at right angles, but that the field gradually becomes narrower.

The length A B is 1783. Divide 100,000 by 1783, and the quotient 56 is the breadth to be taken for an acre. This may not appear quite correct, for if you were to set off 56 on the line A D, and then measure along parallel to B C, you would find the length but 1763, the field having become 20 links shorter in that breadth, and if the medium between

$$\left.\begin{array}{r} 1763 \\ 1783 \\ \hline 2)3546 \\ \hline 1773 \end{array}\right\} \text{viz. 1773 must be the divisor}$$

$$1773)100,000(56 \\ 8865 \\ \overline{} \\ 11350 \\ 10638 \\ \overline{} \\ 712$$

it would produce but 56, with a larger remainder, so that it is nearly as correct as needful, for in the affair of reaping or mowing, half a perch either way is considered immaterial; custom and proper feeling, however, always make the *half perch* a *whole one* for the advantage of the labourer.

Now with regard to the 2nd cant, knowing that the breadth of the first is 56, set off about 30 links along A D; and from this spot measure parallel to A B, this will give a medium length, which is found to be 1755; divide 100,000 by this, and the breath will come out 57 nearly, in short so near that it may be adopted. Proceed in this manner, as shown in the sketch, until you come to what is called the vent cant, and this may be calculated in a similar way to the offsets in some of the preceding examples; that is to say by taking the offset 30 near D, and measuring along the edge of the last cant, till at right angles with the first irregularity, viz. at 460 where the offset is 94, then to the end, observing the offsets as in the sketch; the area of the last piece will be 0a. 3r. 34p. but, as the decimal exceeds 5, it should be called 0a. 3r. 35p. The area of the whole field is 10a. 3r. 35p.

It might have been sufficiently correct to have mea-

sured only about three or four lengths, and so have taken
an average; but of this the surveyor can best judge in
the field, always bearing in mind that "whatever is worth
doing at all, is worth doing well." And if a neat plan
of the field be made in the farming book, and the breadth
of each cant inserted as in the foregoing sketches, it will
be available year after year, the farmer having but to
refer to his book, measuring up the side A D, and placing
stumps at each acre.

As, of course, the ploughing will not always be from
A towards B, the same field may be set out in the
opposite direction, and stumps driven down at the time,
or a plan made of it in the farming book: each cant might
be numbered, and placed against the name of the work-
man in the cash account.

The same field canted out in the opposite way will
suffice for an example. If the work is intended for
plotting as suggested, each field must be measured in the
usual way first; but if merely for setting out the cants,
this is unnecessary.
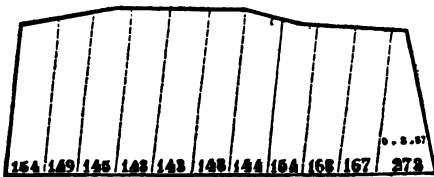
The breadth of each cant being given in the above,
let the pupil ascertain the length of each.

In measuring a field for the purpose of ascertaining
the quantity of land ploughed, mowed, or reaped, &c.
the fences are not included; the dimensions are taken
only as far as the "plough and scythe go;"—this is of
importance, particularly in the weald of Kent and Sussex,
where the hedge rows, or shaws, are of considerable
width in almost all the arable fields. An example will
sufficiently explain the case.
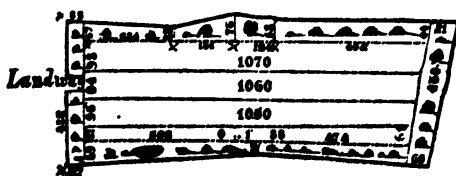
	A.	R.	P.
Arable	3	1	33
Shaws	1	2	5
Landway	0	0	2
	5	0	0

I leave it for the pupil to calculate the respective pieces.

A farmer is often required to find the content of small pieces of wood, called shaws, or shaves, abutting different fields. These are of infinite forms, and may be measured as described for the vent cants of fields, in the manner of offsets, as in the few last examples, and calculated exactly the same. Instead, therefore, of encumbering the book with unnecessary figures, let the pupil consider the sketches, pages 28, 29, 32, &c. &c. to represent shaws, and by attending to the rules and explanations thereto annexed, he will derive a sufficient idea of the way of measuring and computing them.

The same remark holds good with regard to trenching or grubbing.

A farmer has a field of tares as below, containing 9a. 2r. 22p.; it is his intention to reserve to himself that quantity which shall measure 325 links, or 13 rods, along the fence A B; and to sell the remainder in cants as follow :

	A.	R.	P.
No. 1	0	2	14
2	0	1	20
3	1	1	0
4	2	0	0
5	the remainder, after deducting the quantity reserved for himself.		

		o	r	p
Reserved		3	3	1
N° 1		2 . 14		
		1 . 36		
3		1 . 1 . 0		
4		2 . 0 . 0		
5		1 . 2 . 27		

9a. 2r. 22p.

Suppose an arable field of the following form and dimensions, the fences being at right angles; it is required to set off 2a. 2r. for the purpose of converting into a meadow.

New Meadow

Arable
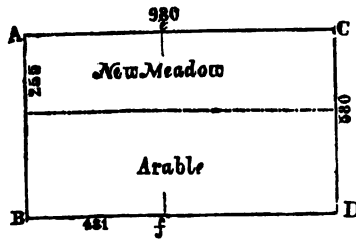
Reduce the given quantity into links, and divide by the length or breath required, thus :

$$
\begin{array}{l}
\text{100000 links in an acre} \\
\quad\;\; 2 \quad ,, \\
\hline
\text{200000} \quad ,, \qquad \text{2 acres} \\
\;\;\text{50000} \quad ,, \qquad \text{2 roods} \\
\hline
\end{array}
$$

length of fence 980) 250000
breadth required 255   196
$\overline{}$ $\overline{}$

            . 540
            490
            $\overline{}$
            . 500
            490
            $\overline{}$
            . 10

. Had it been proposed to set off the new fence on line A C the work would have been thus :

                    580) 250000 links 2a. 2r.
breadth of fence on 431   232
line A C, viz. A *e* B *f* $\overline{}$
                              . 180
                              174
                              $\overline{}$
                              . . 60
                                58
                              $\overline{}$
                                . 2

When the given line is irregular, and the offsets are to be included in the quantity to be set off.

Find the area of the offsets by one of the former rules, and, deducting it from the quantity, proceed as before.

For example :
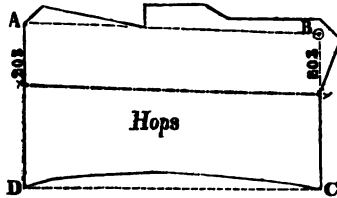
It is required to set off 2a. 1r. 20p. of the above field, including the irregular fence, the remainder to be reserved for hops. Quere, How much hop ground will there be?

If called upon actually to perform this in the field, you should measure it as a trapezium, A B C D, taking the offsets as before instructed, also having a diagonal and proof lines as particularized in the following field book, from which construct the figure.

				500	42	
				300	36	
				200	30	line 3
				⊙	0	
	1048	to D	from	500	C	
from	⊙	B				
				0	500	to C
				0	200	
	1074	to C		50	24	line 2
from	A			fr.	934	B
	500	to A			962	
line 4	from 948	D		46	934	to B
				46	628	
	948	0 \to D		83	598	line 1
	900	14		70 0	410	
line 3 continued	800	30		60	70	
	700	38		0	⊙	
				fr.	⊙A	

The calculation would be thus:

428 ⎱
438 ⎰ perpendiculars

2)866

——

433
1074 diagonal

——

1732
3031
4330

——

465042
47693 offsets in bounds found as before.

5.12735
28036 offsets outbounds on line C D to be deducted.

4.84699

3.38796

15.51840

	A.	R.	P.	
To set off the	2	1	20	deduct the
offsets on line	0	1	36	A B
	1	3	24	and reduce this
				remr. into links

| A.	R.	P.		LINKS.
1	0	0	=	100000
0	2	0	=	50000
0	1	0	=	25000
0	0	24	=	15000 .
1	3	24	=	190000	divide this sum

by the length of line A B 934)190000(203
1868

..3200
2802

.398

The quotient 203 is the breadth to be set off on lines A D and B C.

From	4	3	15	total area of the field
Subtract	2	1	20	the given quantity
Reserve	2	1	35	for hops

It is intended to grub an acre on the north and south sides of the subjoined wood. Required the two lines of fence and the quantity of wood left.

550   160   263   582   705   303

160

G   r   P
3 . 0 . 30

815   ℓ   d   668   594
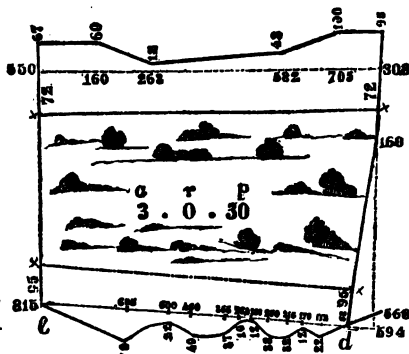
The offsets on the north side, calculated in the usual way, amount to 1r. 26p. which subtracted from

A. R. P.
1 0 0   the quantity to be grubbed
0 1 26   offsets

0 2 14 = 58750 sq. links, these divided by 808 length of the line, give 72 (nearly 73) links for the breadth to be set off on the east and west sides, from ⊙ s. 550 and 808.

The offsets on the south, amount to 1r. 6p., this deducted from

A. R. P.
1 0 0
0 1 6

0 2 34 = 71250 sq. links

Now, as the S.E. side of the fence is irregular, it would be better to get an avarage, by taking the length at about 100 links from *d* and *e*, add the two lengths, and by this average 763, divide the 71250 links, the quotient 95 is the breadth required, from the corners *e d*.

		A. R. P.
The total area of the field is		5 0 30
Deduct for grubbing......		2 0 0
Area of wood remaining ..		3 0 30

815
Deduct 58 outbds.

757
770

2)1527

763 average

To set out a straight fence, in lieu of a crooked one, between two fields, so that the quantity shall remain the same in each.

Let the following represent two fields No. 1 belonging to Mr. Green, and No. 2 to Mr. Brown. The line of division between the properties being very crooked, consequently inconvenient for both parties, they resolve to to have a straight fence set out in such a way that neither shall gain or lose thereby.
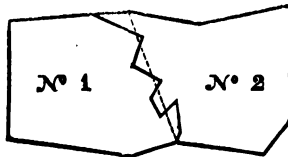
The dotted line represents the required fence; and is found by equalizing the crooked fence as described in p. 56; but before this could be done, it would be necessary to measure and plot the fields. Therefore, as efficiency is acquired only by practice, the following field book and plan may be supposed a case in point.
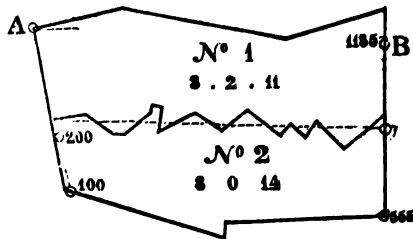
Let Nos. 1 and 2 represent two fields divided by the crooked fence; required a straight line in lieu thereof, which shall equally divide the original fence.

The fields must be plotted by the following field book, the respective ⊙s in which correspond with those on the sketch.

This new fence which you will find by equalizing as heretofore,* will serve for calculating the area; and the north and south sides also being equalized, the quantity is found by two trapeziums.

---

* It would depend upon the arrangements of the respective owners, which end of the fence should be altered; one end would remain the same while the other would be moved; in this case the dotted line shows the new fence as being near ⊙ 300 line 2, about 30 links lower than before.

Diagonal	1260	to ⊙ A
	1000	
0	745	
	662	
fr.	555	line 2

	5	516	No. 1
	10	235	No. 2
		200.	line 4
	fr.	1000	line 3

	1043	to 300
	1000	
	960	
	868	60
	830	
32	800	
0	750	
30	703	
0	660	
60	605	
12	530	
57	490	
80 20	364	
12		
52	340	
0	236	
0	184	
50	100	
fr.	200	line 4

This line serves as a proof.

line 5

	0	1018	Mr. Haynes.
120	78	1000.	line 8
		500	
	fr.	555	line 2

		555	0
		300.	
		255	0
	fr.	1135	line 1

line 2

	-104	1135.	B
		1000	No. 1.
	0	790	
	90	292	
	0	⊙	
	fr.	⊙A	

Mr. Eaton.

line 1

Field book to the plan of a wood * p. 77.

			Mr. Baker		
				0	815
				70	605
				22	500
				48	450
				37	365
Proof	463	to 815 ᵇ		10	330
fr.	500	Diagl.		12	290
				38	250
				32	215
				12	170
				22	112
Diagonal	962	to 58 ᵇ		0	58. A large Oak.
	500.	for Proof		fr.	594 Parallel with line 1 westerly.
fr.	⊙ A			594	Outbounds.
				568	
				160	0 Mr. Spink
Mr. Pryer	0	550	to ⊙ A	fr.	⊙808 1 Go south.
	fr.	815	ᵇ	95	808 +
			Mr. Ballow	100	705
				42	582
				12	263
				60	160
				67	⊙ line 1
			Begin at N.W. corner.	⊙ A	Go easterly.

* This wood being felled, and the stubs, "few and far between," for which reason the proprietor intended grubbing, I was able to measure within the fences, and not intrude much on the adjoining property as explained in page 81.

To measure Woods, Ponds, Lakes, Quarries, &c.

If done without a theodolite, it is necessary to measure each side, and by extending some of the lines, form the connecting angles in the adjoining property. The following figures and explanation will fully exemplify the method.
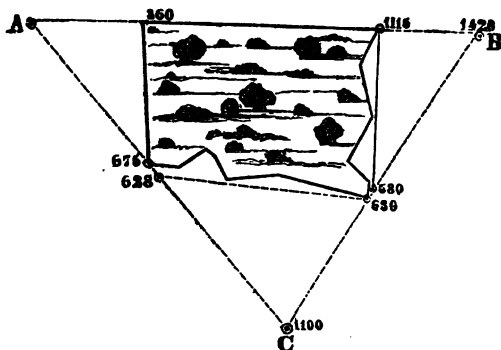
Let the above represent a wood so thick, that unless much trouble be taken in cutting washes, it would be impossible to get through it with any correctness. Providing the same objection did not arise in the adjoining ground, I should form a triangle (by means of the sticks and marks before explained) for as no diagonal could be taken through the wood, it becomes necessary (being a four sided figure) in order that each side should have its right bearing, that such bearings or angles should be found by artificial means. Thus, lines 4 and 5, at the same time that they give the offsets, also define the exact situation of the sides of the wood; for the ⊙s from which, and into which they run, being fixed, it follows, that if the work be correctly measured and planned, the true figure of the wood is given. It is unnecessary to measure the west side, for being straight, and the lines of construction A B and A C just touching the corners of the same, the true position is obtained.

E

				1250	to A	
				1000		
0	490	to 1115		675	0 wood	
50	385			628.		
20	230		from	1100	C	
86	90					
10	40			1100	to C	
from	580	line 2		1000		
				630	3 wood	
				580.		
3	670	to630line2	from	1420	B go south	
50	400					
16	233			1420.	to B	
35				1115.	0	
90 70	170			1000	wood	
40	43			360	0	
from	628	line 3	from	⊙A	go easterly	

The wood calculated as a trapezium by equalizing the offsets, contains 3a. 1r. 2p.

But it frequently happens, that impediments arise, so as to prevent your forming a triangle; the same wood might then be measured by different means; say the following. The pupil, however, if he exercises any judgment, will easily be able to discover the readiest way; and to do this, he would find it no loss of time first to walk round the wood, and examine its different points. I have sometimes been, from various causes, in a great hurry to finish measuring a field; but never had reason to regret thoroughly examining and arranging my plan of operation; without this, you may

frequently find, when nearly completed, obstacles you little expected to encounter, and which may cause you much inconvenience and delay.

It may be readily perceived that by extending the line A B to the points *m* and *r*, and from those points running short lines into stations *n* and *g* on the lines A D and B C, the bearings or angles of those lines are given. The same is applicable by extending the line A D to *o* ; and from that point, running into ⊙ *p* ; but the accuracy of this work materially depends upon keeping the lines perfectly straight. The pupil should, from the above, construct a field book. I imagine it unnecessary to give the calculation, as it may be found, either by equalizing the offsets, or by the method already so often explained.

The following field book gives the method of measuring it.

					490	to 710	
	550	to (·) on the back extension of line A B.					
from	530	6		from	462	g	
					735.	to C	
wood	0	1008	to A		8	710
	530.		6			462.	g
	0	246	+ 543		40	430
from	408				0	270
	408			35	70 50	200
from	227.	p		16	100
				0	⊙
	0	543	D	from	432.	B
	58	440		710.	r
	18	275	0	432.	B
	227.	p	wood	0	⊙
wood	80	140	from	⊙ A
	7	90
	fr.	735	C	245.	m

wood

70 50 35

back extension the purpose of angle of · of line A B for ascertaining the line A. D.

Supposing the owner wished to divide this wood into lots or cants for sale, each cant to measure half an acre, or thereabouts, and the washes to run parallel to line

A B; required the breadth of each; and a neat sketch of the same.

In setting out cants of wood in Kent, the wood-reeve follows as nearly as possible the original falls, and *estimates* the area; habit in this, as in other matters, giving skill. The cants are then described in the catalogues for sale, as containing *about* such a quantity, and sold at per acre, subject to admeasurement when felled; by which greater accuracy is acquired than by measuring while the wood is standing, one of the most difficult and disagreeable tasks of the land measurer.

In this example the wood-reeve finding that the side A B measured 432, or as he would say, a little more than 17 rods, would calculate that it would require about 4½ rods for the half acre, and would therefore on the fence A D set off that distance. Our plan would be to divide 50,000 (links in half an acre) by 432, which would give a result of 115½ (say 116) links, the breadth required on line A D.

The next cant being irregular on fence B C, and somewhat shorter, he might judge the deficiency; or in order to set out the lots to greater advantage or more to his convenience, not being confined to half an acre exactly, he would probably carry the division to the point *e*, which would leave the next cant more regular, and consequently easier to measure;—the result is 0a. 2r. 18p. His judgment would then tell him that the length of the wash being greater than at first, the breadth must be proportionably diminished, taking it therefore at 110, it gives 0a. 2r. 2p.
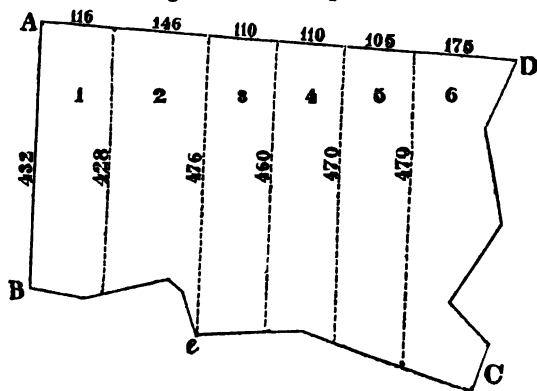
The next cant may be placed at the same width, viz., 110, giving an area of 0a. 2r. 1p.

Cant the 5th running still longer at the bottom, may be judged at 105 for the breadth.

There now remains the vent cant, of which a wood-reeve would merely make a guess for the time; but which, as in the others, would be accurately measured when felled, on the principle of offsets so frequently explained, and computed by small trapezoids, &c., or by equalizing the crooked boundary.

Area of part of Monkdown Wood, in the Parish of Thurnham.

	A.	R.	P.
Cant 1	0	2	0
2	0	2	18
3	0	2	2
4	0	2	1
5	0	2	0
6	0	2	19
	3	1	0*

This may be readily proved by calculating the wood in the usual way as a trapezium.

The examples and instructions given for measuring woods, when unable to work within them, may be also applied to ponds, meres, quarries, &c.; for instance, you have but to imagine the figure of a wood, page 81, to be a pond or a quarry, and then adopt the same method of measuring it.

* If the proprietor of the wood, on being satisfied of its being correctly canted out, were to have a small map of it made similar to the foregoing, and inserted in his farming book, and were to plant a peculiar tree at the extremity of each cant, he would find it extremely useful, always proving a satisfactory reference between him, the steward, and the wood-reeve.

TO MEASURE BUILDINGS, SO AS TO MAKE A GROUND PLAN OF THEIR SITE.

The following instructions compared with the figure may, I trust, be easily understood.

First.—Examine well the premises. It is equally of importance with getting the exact measure to find the true angle of the different sides and irregularities of the building. Generally speaking, the sides (at least one of them) are at right angles with the front or back. This can be easily ascertained on the ground, and when found to be so, it is better to measure with a tape * the length of the front, and making a neat sketch of the same, mark
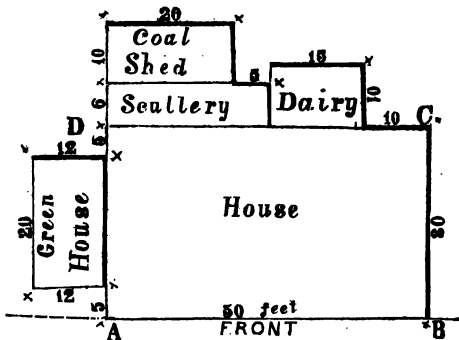
the number of feet and inches on the sketch, as

---

* The measuring tape is a very useful and commodious " pocket companion" for a surveyor, nor ought any steward or bailiff to be without one. These tapes are made of different lengths, some of two rods, others of four, &c. I would recommend the latter, having links on one side and the corresponding feet and inches on the other. It ought to be remarked, when it is known that the admeasurement, even of land, is required *in feet*, the surveyor should take the dimensions by one of these tapes, because, being subdivided into inches, the precise extent is more accurately found than by links. When however the surveyor is not provided with one, he would find the table of the comparative measure of feet and links, page 91, very useful.

on line A B with a little + at each corner, showing these as the extreme points. From B measure to C, and neatly mark the length (30 ft.) sketching as you go on, or if you prefer it let the sketch be made before you begin to measure. From C continue to the next projection, thence, following each irregularity, go on until you come to D, where, if you have carefully observed the structure, you will find that the back wall thereof, runs direct through, from C to D, and that the projections form offices; what these are you will ascertain, and insert as in the plan. Measure from D to the greenhouse, then the three sides thereof, and so on to the front at A.

This may now be plotted from a scale of equal parts. Draw the line A B at pleasure, set off its proper length 50 feet.

Upon this line, at point B, raise a perpendicular for the side B C, and mark off its length (30 ft.) which will be point C. Now, for the back of the house, raise a perpendicular from C, or, with the parallel rule, draw a line parallel with A B. Prick off the distance to the projection for the dairy, and by letting the line C D run through, you will afterwards ascertain if the work be correct, by the other parts fitting it.

Draw each projection in the same way, taking care to keep at right angles, (except when otherwise expressed,) and also being very particular in pricking off the dimensions.

The plotting is much more readily accomplished by using a small (ivory) scale, feather-edged, and graduated the same on each edge, so as to save the trouble of raising perpendiculars.

If, as in page 42, it should be necessary to show the situation and plan of a building, ascertain by means of your link staff, when you are at right angles with the corner; thus, in the example alluded to in page 43, line 2, there being a lodge which it is desirable to

	740	
25+		
▓30	0	550
▓30	0	512
	424.	

show in the plan, it is noticed as in the extract from the field book; that is, at 512 I found myself at right angles with the lower corner, and at 550 with the upper corner of the lodge; from each of these points I measured to the respec- tive corners, then, seeing that the building was a regular parallelo-gram, it became necessary only to take the dimensions of one side, and plot it thus: the little + or sign plus, signifying that the offset reads 30 and 25.
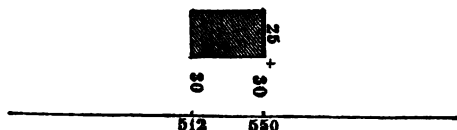

The length of the building is of course given by de-ducting 512 from 550, viz., 38 links or 25 feet.

Another example occurs in page 44.

The following plan will perhaps be sufficient on this subject; a careful examination of it, compared with the field book and the previous remarks, will fully explain the system :—

House and Premises situate at Boxley, the Property of William Boys, Esq.
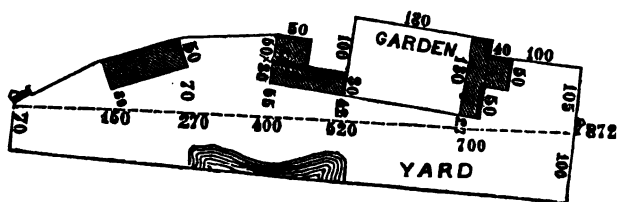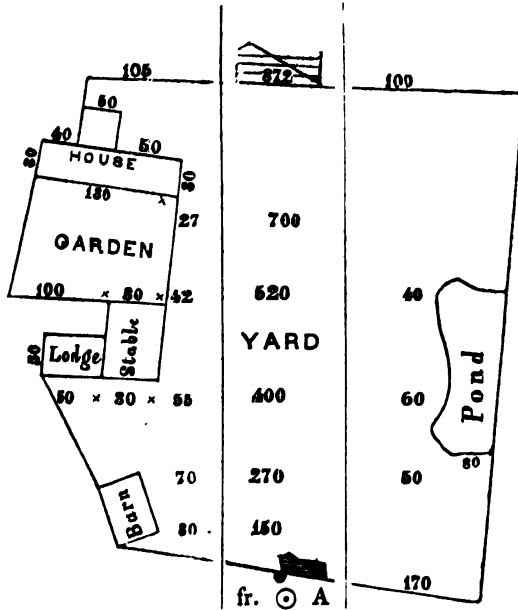
In the note to page 87, describing the measuring tape, an observation is made, respecting the dimensions being given in feet, and as it not unfrequently occurs that the owner may wish to know the actual admeasurement of his house, out-buildings, frontage, &c. in *lineal feet*, I have calculated the following table, which, in the absence of the tape, may save much time and labour, objects well worthy a surveyor's attention.

TABLE

SHEWING THE COMPARATIVE MEASURE OF LINKS AND FEET.

Inches.	Links.	Foot.	Yard.
7.92 =	1		
12. =	1.5151	= 1	
36. =	4.5454	= 3	= 1

Links.	Feet.	Links.	Feet. Yds. Rods.
1.51	1	75.75	50=16½=3
3.03	2	83.33	55
4.54	yd. 3=1	90.90	60=20
6.06	4	100.	chain 66=22=4=1
7.57	5	106.05	70
9.09	6=2	113.63	75=25
10.60	7	121.20	80
12.12	8	136.36	90=30
13.63	9=3	151.51	yds. ft. rods. ft. 100=33 1=6 2
15.15	10	203. 2	200
22.72	15 =5	454.53	300=100
25.	rod 16½=5½=1	606.04	400
30.30	20	757.55	500
37.87	25	909.06	600=200
45.45	30=10	1060.57	700
50.	33=11=2	1212.08	800
53.02	35	1363.59	900=300
60.60	40	1515.10	ft. rods. ft. chains. lks. 1000=333 1=60 10=,6 15
68.18	45=15		

It will be observed that I have adopted but two places of decimals, that being sufficiently accurate for the purpose, neither is it absolutely necessary to make use of the decimal parts of a link, except in cases of extreme nicety.

The practical use of the foregoing table may be shown by the following examples :—

The frontage of a lawn measuring 366 links, how many feet ?

	LINKS.		FEET.
In the table opposite	100	is found	66
	3		3
	300	=	198
	60	=	40
	6	=	4
	366	=	242

A garden wall measures 83 feet, how many links ?

	FEET.		LINKS.
Opposite	80	is	121
	3	=	4
			125

Proved by multplying the number of links in a foot 1.51 by 83

$$453$$
$$1208$$
$$125.33$$

A TABLE

SHOWING THE SQUARE LINKS IN ANY NUMBER OF ROODS
OR PERCHES.

ROODS.	SQ. LINKS.
1	25000
2	50000
3	75000

PERCHES.	SQ. LINKS.	PERCHES.	SQ. LINKS.
1	625	21	13125
2	1250	22	13750
3	1875	23	14375
4	2500	24	15000
5	3125	25	15625
6	3750	26	16250
7	4375	27	16875
8	5000	28	17500
9	5625	29	18125
10	6250	30	18750
11	6875	31	19375
12	7500	32	20000
13	8125	33	20625
14	8750	34	21250
15	9375	35	21875
16	10000	36	22500
17	10625	37	23125
18	11250	38	23750
19	11875	39	24375
20	12500		

TABLE

To ascertain the number of Roods and Perches in a given
number of decimal parts of an Acre.

P.	O.	1 Rood.	2 Roods.	3 Roods.
0	.000	.250	.500	.750
1	.006	.256	.506	.756
2	.013	.263	.512	.763
3	.019	.269	.519	.769
4	.025	.275	.525	.775
5	.031	.281	.531	.781
6	.038	.288	.538	.788
7	.044	.294	.544	.794
8	.050	.300	.550	.800
9	.056	.306	.556	.806
10	.063	.313	.563	.813
11	.069	.319	.569	.819
12	.075	.325	.575	.825
13	.081	.331	.581	831
14	.088	.337	.588	.838
15	.094	.344	.594	.844
16	.100	.350	.600	.850
17	.106	.356	.606	.856
18	.113	.363	.613	.863
19	.119	.369	.619	.869
20	.125	.375	.625	.875
21	.131	.381	.631	.881
22	.138	.387	.638	.888
23	.144	.394	.644	.894
24	.150	.400	.650	.900
25	.156	.406	.656	.906
26	.163	.413	.663	.913
27	.169	.419	.669	.919
28	.175	.425	.675	.925
29	.181	.431	.681	.931
30	.188	.438	.688	.938
31	.194	.444	.694	.944
32	.200	.450	.700	.950
33	.206	.456	.706	.956
34	.213	.463	.713	.963
35	.219	.469	.719	.969
36	.225	.475	.725	.975
37	.231	.481	.731	.981
38	.238	.488	.738	.988
39	.244	.494	.744	.994

The use of this Table is merely to save the trouble of multiplying by 4 and 40, which, by any expert hand, may (it must be confessed) be as quickly done as by a reference to the Table. It will be observed that only three decimal places are used instead of five.

Suppose it be required to find the content of a field, thus:

$$980$$
$$760$$
$$\overline{}$$
$$58800$$
$$6860$$
$$\overline{}$$
$$7.44800$$

Now, having cut off the 7 acres, instead of afterwards multiplying by 4 and by 40, look in the Table for the three decimals 448; the nearest to which is 450 in the second column; on the top of this column is 1 rood, and immediately opposite the 450 is 32 p.

Ans. 7a. 1r. 32p.

T A B L E

Of the number of Plants required for an Acre of Land,
from 1 foot to 20 feet apart.

PLANT FROM PLANT.

ft.	in.	Plants.		ft.	in.	Plants.
1	0	43560		8	0	680
1	6	19360		8	6	602
2	0	10890		9	0	537
2	6	6969		9	6	482
3	0	4840		10	0	435
3	6	3556		11	0	360
4	0	272?		12	0	302
4	6	2151		13	0	257
5	0	1742		14	0	222
5	6	1440		15	0	193
6	0	1210		16	0	170
6	6	1031		17	0	150
7	0	889		18	0	134
7	6	774		19	0	120
				20	0	108

CONCLUSION.

The object with which this short Treatise was commenced, is now, I would fain hope, accomplished. That object, as observed in my introduction, was to produce a few pages for the instruction in Land Measuring, of such pupils as are destined to become Farmers or Stewards.

I have not for a moment indulged the idea of this little work being studied by the pupil of a professional surveyor,—of its deficiencies in that respect, I am thoroughly aware. To him a knowledge of the theodolite, spirit level, correct ideas of trigonometry, the system of measuring extensive estates, and of completing parochial surveys, with a hundred *et cetera*, will be absolutely necessary; but to these I have not extended my observations, leaving for such students, the works of those who have preceded me, and who have executed the task with honor and ability.

Should, however, an aspirant to "*the profession*" deign to peruse the foregoing pages with attention, they might, peradventure, be of some assistance, and help to "pave his way;" while that class of readers I more immediately seek, will, I sincerely trust, derive such information from my humble efforts as may, in conjunction with their own ability and exertions, prove of lasting benefit to them.

FINIS.